THE

ENGINEERING MAGAZINE

VOL. XIII. APRIL, 1897. NO. 1.

THE SIGNIFICANCE OF OUR EXPANDING EXPORT TRADE.

By Thomas A. Eddy.

THE increase in our exportation of manufactured goods for 1896 is without a parallel in the history of American commerce, being an advance of $45,000,000 beyond that of 1895. And not only is the sum of this exportation—$228,571,000—by far the greatest, but the ratio of of exports of manufactures to all our other exports is also by far the highest yet reached—more than 26 per cent.

This development is of inestimable importance, to American engineers especially, because where American manufactures—and especially American machines and tools, which constitute a large proportion of our exports—are introduced, American practice, superintendence, and exploitation naturally follow. The debt of the manufacturer to the engineer, for both direct and indirect assistance in the expansion of trade, has often been pointed out. It needs to be recognized that there is a converse to the proposition.

The development of mining, of railroad building, of electric-traction, power, and light installations, and of civil, municipal, sanitary, electrical, and mechanical engineering work of every character, is but in its infancy in the newer countries of the world. The entry of our manufactures and machinery in their markets is the key which will open almost limitless room for American engineering enterprise and engineers.

The United States has long held a commanding position in the exportation of agricultural products, but the building up of the outland trade in manufactures has been a work of time and infinite persistence in overcoming great natural and artificial obstacles. The surplus cap-

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ital of Europe, instead of being invested at home at low rates of interest, seeks employment abroad, and has been largely instrumental in developing the export trade of the countries on the other side of the Atlantic, whose bankers regard as one of the most lucrative branches of their business the furnishing to their merchants of credit facilities for foreign trade; and these facilities they provide on terms so liberal that relatively small capital can control large undertakings. They naturally provide first for their own countrymen, with whose methods, resources, and operations they are familiar, and over whom they can exercise control.

American merchants and manufacturers, wishing to do foreign business on a large scale must, in addition to their own capital, utilize such surplus facilities as the foreign banker can devote to their necessities, after reserving the resources required to care for his nearer friends. In the absence of American banks abroad, our foreign trade is dependent on the amount of credits we can secure from European agencies. The English and European banks and bankers have so admirably organized their branches or agencies, throughout the world, that, under present conditions, we must use their facilities; and they receive a commission upon every shipment of American merchandise, whether to South America, South Africa, or the east. We need an American international bank.

With our large demand for the raw materials produced by other countries, such as coffee, rubber, sugar, hides, and wool, from South America, and the products of the far east, we have a basis of exchange to warrant the establishment of an American bank having branches in all important trade centers in South America, and agencies in Australia, South Africa, Japan, China, and India. With such a bank extending its influence to the far parts of the world, furnishing credit facilities for the exchange of American products for those of other countries, and always in touch with each transaction, we should transfer to American pockets the millions now paid to foreign bankers in the shape of commissions and interest, and be brought in touch with the industrial enterprise of new countries. It would enable American capitalists and contractors to undertake the building of steam and electric railways, docks, bridges, piers, and other public works, and, consequently, enormously broaden the field for our manufactured goods. The excess of our exports over imports would become a permanent feature of our statistics, making certain the annual flow of gold to the United States, every dollar of it representing a profit from which we are now shut out.

In the congress of all the American republics held a few years ago in Washington, chiefly for the purpose of developing more inti-

mate trade relations between the peoples of this continent, a resolution was unanimously adopted recommending to the governments represented the establishment of an International American Bank, under an act of congress of the United States, with branches in all the republics of Central and South America. Without such a system large trade operations in foreign countries are impossible. The commerce of Great Britain is most efficiently sustained by a net-work of banking-houses and agencies covering the whole world of trade, and directed from London. In London there are no less than sixty incorporated banks having for their sole function the conduct of international finance as related to commerce; these banks are concerned with international trade exclusively, and have nothing to do with the finances of governments.

The capital and surplus of these international banking-houses of London are nearly five times as great as those of the national banks of New York, the commercial center of America. The capital of those sixty London banks amounts to nearly $300,000,000, with surplus of $70,000,000, and their deposits exceed $1,200,000,000. Nor is that all. There are in London private banking-houses, with capital aggregating over $175,000,000, which give material aid to the foreign trade of the kingdom. The vast foreign trade of Great Britain, amounting to more than three thousand million dollars a year, is financed easily and safely by this admirable system of banks, branches, and agencies; and not the British foreign trade alone, but the larger part of the foreign trade of all other countries, including our own.

Of England's international banking capital, one hundred million dollars sustains and facilitates her commercial transactions with the United States and Canada. The products of the republics of South America are brought to market with the aid of eighty million dollars of British capital, whatever their destination may be; naturally the chief destination is England. The American importer of coffee or rubber from Brazil pays tribute to a London banker. To the trade of China and Japan with the rest of the world, twenty-five million dollars of British capital affords the ways and means, without which the opening of their ports to the western world would be a nullity. On the continent of Europe the English banking capital employed in financing trade equals the whole capital and surplus of the national banks of the great city of New York. About seventeen hundred branches and agencies are the organs of communication between the banks in London and their clients all over the world—just about half the number of the national banks in the United States; the capital of those London banks is considerably more than half as large as the authorized capital of all our 3,667 national banks. The advantage thus

secured to the British merchant over his competitors is patent. The British merchant or manufacturer may draw against a shipment to any part of the globe, and cash the draft at once, while an American merchant or manufacturer must be his own banker, if he engages in foreign trade, unless he has an established footing in London, in which case he may avail himself of English facilities.

Again, our foreign commerce is urgently in need of proper shipping facilities—such shipping facilities as can be afforded only by regular lines of fast steamers. European governments have given proof of their desire to assist their merchants in developing foreign commerce, in the very liberal subsidies granted to vessels carrying their flags and trading with foreign countries; they recognize the fact that every penny's worth of merchandise exported represents that much wealth given by the foreigner in exchange for the product of their home industries; and they wisely provide the means of effecting that exchange by subsidizing steamship lines. Whenever similar aids are asked of congress on behalf of American commercial and shipping interests, a wide difference of opinion is seen to exist regarding the principle that "trade follows the flag." Speaking from an experience of twenty-five years, I can affirm the truth of the proposition, provided the measure of protection extended to the "flag"—*i. e.*, to the mercantile marine carrying the flag—is sufficient to warrant a swift and regular service. American ship-owners have had to compete for foreign carrying-trade on a free-trade basis, against the protected lines of foreign countries, and have gradually seen their ocean tonnage shrink almost to the vanishing-point.

Notwithstanding the statement so often published that she pays no subsidies, Great Britain has been generous in mail contracts and naval subventions where they were needed for the development of her commerce. She pays no subsidies for her Indian, Australian, or South African service, it is true, but it must be borne in mind that the Indian government has for years paid heavy subsidies to English steamship companies, while South Africa, the Australian colonies, New Zealand, and Tasmania have contributed liberally to secure swift and regular service. Canada pays, through the subsidized Canadian Pacific Railroad, for maintaining a fine service to Japan and China. It is only since congress authorized mail subsidies to certain American steamship lines that we have seen our flag with increasing frequency in foreign ports.

Our shipping should be protected, to give our export trade full development, and to remove one of its most serious disabilities—the lack of proper communication with the markets. An efficiently-protected mercantile marine would return to our ship-owners, for ex-

penditure in the United States, the millions we now pay to have our goods carried to our customers abroad. *

With his command of credits, and fast steamship communication with his foreign markets,—advantages which he has enjoyed for years past,—the European merchant has been able so to entrench himself in the non-manufacturing countries of the world that it has been most difficult to assault his position. English houses have their branches and agencies in those markets, working in perfect accord with the bankers and steamship lines. They have so perfected all facilities that it requires something more than the cheapness and adaptability of merchandise manufactured in the United States to overcome the competition of this long-established trade. We cannot always win on the merits of our goods; we must be able to offer as great conveniences for trade as our competitors.

Despite these disadvantages, our export trade in manufactured goods has slowly grown, until, in the year just passed, it has reached unexampled proportions; and, having reduced the manufacture of

* We are glad to afford Mr. Eddy the opportunity to state the case for shipping subsidies so clearly and so forcibly, but, far from sympathizing with his view, we are earnestly opposed to it. The plain English of a shipping subsidy, to our thinking, is to vote the people's money into the pockets of a few ship-owners. And whereas honest men may differ as to the wisdom of that governmental policy, there can be no question about the grave danger of inaugurating it at this time.

Of all countries in the world, England would be most warranted in voting subsidies to her ship-owners, and yet her statesmen do not dare to adopt that policy, simply because the English people would not tolerate it for one hour. Mr. Eddy indicates how the end is accomplished, in some measure, by indirect methods. But the reasons why British statesmen and colonial governors strive to do indirectly what they do not dare to attempt openly, are very clearly set forth in the following ominous paragraphs, taken from "Democracy and Liberty," the great work recently written by Mr. W. E. H. Lecky, the distinguished historian and Conservative member of Parliament. He says:

"The enormous increase which has taken place in the taxation of nearly every civilized country during the last forty-five years is certainly one of the most disquieting features of our time. National indebtedness has reached a point that makes the bankruptcy of many nations an almost inevitable result of any prolonged European war; and the immense burden of unproductive expenditure that is drawn from every nation for the purpose of paying the national creditors, *gives revolutionary literature a great part of its plausibility*, and *forms one of the strongest temptations to national dishonesty.*

The burden is a terrible one; but every one who will look facts in the face must recognize that the existence at each given moment of an English fleet of overwhelming power is the first and most vital condition of the security of the nation. An island Power which cannot even support its population with food; which *depends for its very existence on a vast commerce;* which from the vastness of its dominions and interests is constantly liable to be involved in dispute with other Powers, and which presents peculiar temptation to an invader, could *on no other condition maintain her independence*, and it is a healthy sign that English public opinion realizes the transcendent importance of the fact, and has more than once forced it upon politicians who were neglecting it."

Now, if the advocates of subsidies imagine that this country is exempt from the evil

various kinds of merchandise to a science, we can, in most of the articles produced from our own raw materials, compete with foreign nations. The extent of the practical success we have already attained in this direction can not be better exhibited than by quotation from an address by Prof. A. E. Outerbridge, Jr., recently delivered to the students of the University of Pennsylvania. Prof. Outerbridge says:

Two years ago an Alabama furnace sent an experimental shipment of two hundred and fifty tons of pig-iron to England. This was considered an "exceptional case," and was also pronounced a visionary project, and derided as ridiculous in the extreme.

Within this brief period, says the *Manufacturers' Record*, the demonstration is complete.

"From that experimental two hundred and fifty-ton shipment this business has increased, until now there is an actual scarcity of steamer-room to handle the business offered. Orders are being booked every week for large shipments to England and to continental countries. It is difficult to rightly measure the influence of this trade upon the world's commercial interests."

From a recent statement by an officer of a leading furnace company, the foreign orders booked by that company alone amounted to about 40,000 tons, and inquiries

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portents of an enormous increase in the burden of taxation, they can gather light from the following extracts from a recent editorial in the New York *Sun*—the Democratic champion of protection, and a peerless advocate of our new navy and our new merchant marine:

THE COST OF RUNNING THIS NATION.

"The table subjoined shows the net ordinary expenditures of the Government, excluding interest, at intervals of ten years since the beginning of the century; together with the population, and the per capita of expenditure to population:

Year.	Population.	Expenditure.	Per capita.
1800.....	5,308,483	$ 7,400,000	$1.39
1810.....	7,239,881	5,300,000	.75
1820.....	9,633,822	13,100,000	1.36
1830.....	12,866,020	13,000,000	1.01
1840.....	17,069,453	24,100,000	1.41
1850.....	23,191,876	37,200,000	1.60
1860.....	31,443,321	60,000,000	1.91
1870.....	38,558,371	164,000,000	4.25
1880.....	50,155,783	170,000,000	3.39
1890.....	62,480,540	321,700,000	5.14
1895.....	70,000,000 (est.)	383,900,000	5.48

Adding the permanent annual appropriations to the appropriations made at the first session of the Fifty-fourth Congress for the current fiscal year, the total for this year is $515,845,194. Estimating the present population at 72,000,000, this is a tax of $7.16 for every man, woman and child in the country.

"For the tremendous increase in the cost of running the Federal Government, outside of the expenses resulting from a civil war which ended thirty-two years ago, it must be said that the Republican party is mainly responsible. It is a party of enterprise, but it has not hitherto shown itself to be a party of economy.

This tendency is the most serious problem which the Republican party, coming back into power under McKinley, will have to confront during the next four years."

A great and growing ocean-tonnage is altogether desirable, but it is neither essential to our "very existence," nor necessary to our independence; and any party which attempts to build up a merchant marine by means of subsidies or differential duties, will be driven from power as inevitably as fate. *Editor.*

under consideration between 30,000 and 40,000 tons. One of these, the same day on which this information was given, covering 5,000 tons, materialized into an order.

Pig iron has already been shipped to Liverpool, Manchester, Rotterdam, Vienna, Genoa, Trieste, Yokohama, and elsewhere abroad. These are facts not yet generally known.

Crude pig iron stands near the bottom of the list of articles involving a high degree of skilled labor. American watches, on the other hand, head the list. Yet they are exported in constantly-increasing quantities to all parts of the world.

Very recently the American consul at Bradford, England, reported as follows:

"One Bradford firm of jewellers alone has a stock of 20,000 Waltham watches. In addition, it has watches of the Elgin and other makes, and sells large numbers."

American files, made by machinery, according to the testimony of Consul Meeker, compete with English hand-made files. He mentions one order, recently sent to this country, for one thousand dozen, whereas an order for two hundred dozen English files would be considered, ordinarily, as a large one.

"Go into any cutlery or hardware shop in Bradford," said Mr. Meeker, "and ask for shears, and you will be handed a pair bearing a Newark or Trenton, N. J., imprint. They are considered superior in every way, and one of the strange things about it is that they must be purchased through Sheffield, which is supposed to be the rival of American cutlery manufacturers. These shears, a dealer said to me, are superior to all others, because they are 'sweet cutters.' The shears used by tailors and cutters are almost entirely of American make.

"Turbine water wheels and printing presses of American manufacture are also sold in Bradford."

Seven thousand tons of steel rails, besides enormous quantities of other railroad material, are now being made in Pittsburg for Japan, and large orders have, it is said, been booked for China.

A complete locomotive manufacturing plant was recently shipped from Philadelphia to Russia, and railroad machinery is now on its way from this port to Australia.

A multitude of similar illustrations could be given, but these will serve as straws to show the direction in which the "trade winds" are now blowing, and it only remains for American enterprise to take advantage of the opportunities which favorable circumstances offer to enter upon a new era of industrial prosperity.

The secret of success in these tentative experiments is to be found in the wonderful advances which have been made in labor-saving machinery, supervised by intelligent, highly-paid operatives, whereby the productive capacity of each employee is enormously increased, and the cost per unit of product correspondingly reduced.

The secret of this success lies primarily in the inventive faculty of the American people. The American manufacturer has been coining the genius of the inventor; coining the American unwillingness to walk in the ancient ways and to "leave well enough alone"; coining the ambition for some simpler, easier, and better way of producing; coining the progessiveness of the American race. He has put in practice, on the largest scale, the modern idea of bringing together under one head the resources and working-capacity of formerly competing enterprises, with the resultant economies. He has taken advantage of the specialization of work in mechanics and in the distribution of the product.

The claim for the people of the United States that they are fore-

most in mechanical ingenuity, inventiveness, business enterprise, and what might be called commercial common sense and intuition, rests, not on sentiment, but on facts patent and confessed on all sides. Hence, were it not for the hindrances just mentioned, the products of American manufacture would easily overcome all European competition in the markets of the world. The testimony of unprejudiced observers everywhere is unanimous in allowing the superiority of American-made mechanical tools of various kinds—saws, hammers, axes, chisels, and the like—to similar European-made wares. An Australian trade journal, in frankly confessing this, concedes to certain wares made in England the palm for "solidity," but remarks that the goods "do not sell themselves," while the American articles do. But is not this faculty of "selling itself" the test of an article offered for sale? The greater expertness and alertness of American artisans is recognized by another English trade journal in telling the story of two factories owned by one firm, one being in Chicago, the other in Leeds. The wages of the workmen in Chicago were about double the wages paid to those in Leeds: but, because of the greater energy and expertness of the Chicago artisans, their product cost less than that of their fellows in the heart of the most industrial community of England. And Hiram S. Maxim, the distinguished American mechanician, for many years resident in England, says that, if a mechanic in England wants "a square that is a square," he must get one made in the United States, for "there are no squares that are square" made in England.

In other countries the product of industry is far from being as great, compared with the number of workers employed, as in the United States. Great Britain for two hundred years has been "the world's workshop"; but the manufacturing and productive power of Great Britain, compared with that of the United States, per inhabitant, is only as 1,470 to 2,000; and in the same comparison Germany counts for only 900, and France for about the same. In productive power—agricultural and mechanical—the United States equals Great Britain, Germany, and France together. The same efficiency of agricultural labor which, aided by machinery, has placed the United States at the head of all nations in the production of foodstuffs is available for conquering unquestioned pre-eminence in manufacture and in foreign commerce. The grain product of the United States, per laborer employed, is 350 bushels, but the product of Great Britain per laborer is only 119 bushels.

Tonnage in manufacture is another important item. The more tonnage produced in any given article, whether steel rails, wire, lumber, or stoves, the lower is the cost of production. Hence, by pro-

ducing an exportable surplus, we reduce the cost for domestic use. Manufacturers have for years neglected foreign markets; while developing their resources and improving their machinery under the keen competition of domestic trade, they have, almost unconsciously, reached a point where they find themselves producing at a cost which enables them to compete with the cheap hand-labor of Europe. During periods of prosperity, the demand in this country has been so great that manufacturers have looked askance at foreign trade, particularly if it involved the adaptation of a part of their plant to meet the prejudices, necessities, or conditions of foreign populations. With the coming of the periodical financial cyclone, these manufacturers have found themselves obliged to reduce their force of workmen, until finally their factories were closed and thousands thrown out of employment; while, on the other hand, the few manufacturers who have worked to develop a foreign trade, have found that, during such periods of stagnation, they have been able to keep their factories busy, or running on part time, earning enough to pay interest on their investment and depreciation of plant, while keeping their men employed on living wages, holding their force together, and maintaining their machinery in running order,—in fact, finding in export trade a haven of refuge wherein to ride out the financial storm, and be in readiness to take advantage of the first break in the weather showing the return of good times. It is an insurance policy for the manufacturer, and one which he will not let lapse, if he be wise.

We have accomplished much, but we can accomplish infinitely more. The policy of this government is distinctively protective, and shipping must be protected to the same extent as manufactures. With swift, regular communication with foreign ports, with an American bank having branches in all the important trade centers of the world, and with a desire on the part of manufacturers to produce a certain surplus above the wants of the United States for export to foreign countries, this country, which is to-day standing in the open door, can step out into the vast field of exportation of manufactured goods, and be in a position to compete on equal terms with the other nations of the world.

SIX EXAMPLES OF SUCCESSFUL SHOP MANAGEMENT.

By Henry Roland.

VI. THE INSURANCE AND ENDOWMENT FEATURES OF DOLGEVILLE.

ALFRED DOLGE was born at Chemnitz, Saxony, December 22, 1848. He was the son of August Dolge, senior member of the firm of A. Dolge & Co., piano-makers of Leipsic. At the age of seventeen, having received a common-school education and served an apprenticeship in his father's factory, he landed at Castle Garden, with little or no money, and, after some vicissitudes, found work with Mathushek, returning to Germany in 1867. Again reaching the United States in 1868, he reëntered the employment of Mathushek, and, while retaining this situation, made some small importations of piano-hammer leather and piano wire on his own account, which resulted favorably and led to his leaving Mathushek in 1869, when he was not yet twenty-one years of age, and beginning business on his own account by marrying an estimable young lady without fortune, and setting up as importer of piano materials on a cash capital of $500, saved from his earnings and his previous ventures with German leather and wire. Seven children have been born of this early marriage, of whom five sons survive, the eldest, Rudolf, being now the junior member of the firm of A. Dolge & Son, doing business at 110–112 East Thirteenth street, New York city, and at Dolgeville, Herkimer county, New York, and rated as having a capital of $1,000,000. Alfred Dolge's first store was in Amity street, near Broadway; thence he removed in 1871 to 122 East Thirteenth street, where he remained until 1893, in which year he again removed to 110-112 East Thirteenth street.

In 1871 Dolge began the manufacture of felt in Brooklyn with four workmen, but his force had increased to fifty-three operatives when in 1874 he purchased the old tannery and with it 1000 h. p. of water power at Brockett's Bridge,—a hamlet of about a hundred inhabitants, eight miles by wagon road north of Little Falls, Herkimer county, N. Y., a station on the New York Central Railroad, 79 miles northwest of Albany, and 240 miles from New York,—paying therefor $7,000 in seven annual payments. The Brooklyn felt works were immediately removed to Brockett's Bridge, at that time little more than a "place in the woods," without stores or railway communication, and took with them such of the Brooklyn workmen as would go to this out-of-the-way spot; only ten finally remained in the new

location, the others being unable to endure the privations of this pioneer life in the Herkimer wilds. Dolge's capital at this time had become about $50,000.

The felt factory increased, natives taking the place of the urbanites who fled from the savage existence in the woods; the manufacture of felt shoes and piano sounding-boards was inaugurated; magnificent granite factories were erected, including a finely-equipped machine shop, where many new machines for facilitating the Dolge manufactures were invented and built; Brockett's Bridge became Dolgeville; a railway was constructed, connecting with the New York Central at Little Falls; fine stores, magnificent schools, an elegant Turn Halle, and other accessories of civilized existence sprang into being under the magical wand of the Dolge management; and to-day Dolgeville has a population of nearly 3,000 inhabitants, and is one of the brightest, liveliest, and most picturesquely-located manufacturing villages in the United States, and stands a magnificent monument to the tireless energy and unerring foresight of its founder, Alfred Dolge, who, still under fifty years of age, has achieved such results in the way of successful manufacturing as have rarely fallen to the lot of man. The Dolgeville productions are recognized the world over as the best of their class, having taken first premiums at the world's fair at Vienna in 1873, at Philadelphia in 1876, at Paris in 1879, and at Chicago in 1893.

Alfred Dolge has seen and known and lived the life of master and man in all the varying conditions of the two estates. He has thought deeply on those questions which extended manufacturing operations involve, and he has formulated and put in practice new devices for securing harmony between employees and employer, which seem, at the end of twenty years of entirely successful practice, to fully meet all the requirements of the situation, and which not only avoid strikes and the dissensions which lead to strikes, but provide insurance for the workmen in case of accident or death, and even reach so far into the future as to guarantee the retirement of the workman on full-pay pension when past the age of effective service in the factory.

The story of Dolgeville and Alfred Dolge's "Earnings Distribution" in the three forms of pension, life insurance, and "endowment" has been printed many times, but never has the story been told from the inside by a narrator who was at once fully informed and wholly unbiased; some have written it hastily from incomplete or misunderstood information; some have written it with an absorbed sense of admiration for Alfred Dolge and his success which left little appreciation for anything else; while others have sought in the workings of the Dolge system of labor recompense a witness to the accu-

racy of their own theories and imaginings, which nothing in the facts of the Dolge methods can be held really to support.

The Dolge "System of Earnings Distribution" embraces the three divisions of pension, life insurance, and "endowment," the endowment feature being simply a gift made under certain circumstances to a workman who is, in Mr. Dolge's judgment, deserving of something more than his wages.

In his youth Mr. Dolge was a firm believer in Socialism as taught by Karl Marx; this was an inevitable result of his early surroundings and the wide benevolence of his character; he could see plainly the hardships of the life of the German workman, and that these were not the fault of the industrious and sober toiler, but of the system under which he worked; and the theories of Karl Marx seemed to his youthful imagination and sensibilities to hold a complete solution.

With increase of years and a full knowledge gained by experience, both as workman and employer, Mr. Dolge, as a matter of course, came to fully realize the insurmountable obstacles which prevent the practice of any commercial system independently of individual effort rewarded, in case of success, by individual gains, and to fully understand that capital is merely accumulated labor, and has all the rights and earning powers of the labor which produced it.

Yet Mr. Dolge's quick sympathies retained, despite his broadening knowledge of commercial realities, a deep pity for the life of the ordinary workman, ignorant of the value and meaning of capital, who spends his earnings as he goes, and finds himself a pauper at the end of his years of usefulness. This pity took on a form of pregnant interest when, after the Vienna Exposition of 1873, Mr. Dolge visited many of the continental piano factories and found them all in the same plight, doing a poor business with antiquated methods and machinery and old workmen, long past their best days. To one after another of the proprietors of these decaying factories Mr. Dolge put the same questions, and from each he received the same answers; they did not adopt the new methods and improved machines which were needed to put them in successful competition with the more modern piano factories which were rapidly monopolizing the trade, because it was impossible to introduce novelties successfully without discharging the old workmen, and they had not the heart to put the faithful servants of the past into the street to starve. As Mr. Dolge tells it, "'Here is something for you to think about, Alfred,' I said to myself. And then I began to think what I would do,—how I could arrange things so I could say to a man, when he could earn his pay no longer: 'You get out; I have had you long enough; I want a younger man in your place.' Then I thought of the pension."

The Dolge pension system has now been in operation for twenty years. At first sight it seems that twenty years is not a sufficient time to fairly test a system with an increasing number of possible pensioners, but a brief consideration will show that a yearly tax of one per cent. of wages paid would undoubtedly cover both the life insurance and pension cost. Pensions are paid to workmen entering service between twenty-one and fifty years of age, and begin to be payable only after ten years of continuous service; at the expiration of the first ten years of continuous service the pension is fifty per cent. of wage, and gradually increases until it reaches one hundred per cent. at the expiration of twenty-five years of continuous service; this puts the age of the youngest full-pay pensioner at forty-six years, and, should such a pensioner live to the age of seventy-one, he would then have drawn double pay for his twenty-five years of work. But, by the conditions, the pension is to be paid only in case of partial or total disability to work, and, as the ordinary workman may be regarded as efficient in most classes of manufactory employment up to sixty years of age, the management has the option of paying the pension or retaining the eligible pensioner in active service up to the age of sixty, which would reduce to eleven years the period of idle pensionership for the supposed life of seventy-one years, as against forty years of continuous service, and so would add but little more than twenty-five per cent. to the wages account to make the total of wages and pension, and the twenty-five per cent. added no more than represents the increased earnings due to continuous service, certainty of avoidance of troubles with labor, and other vast economic advantages resulting from long-continued harmonious association of master and man.

Thus, within the twenty years ending December 31, 1894, there entered and re-entered the Dolge service 2,046 male employees. Of these, on January 1, 1894, 10 had remained in continuous service for more than 15 years, 29 for from 10 to 13 years, and 68 for from 5 to 9 years, making a total of only 107 workmen out of 2,046, or about 5½ per cent., eligible to endowment (which begins after five consecutive years of service), and, of these 107, only 39 had been in service more than ten years, which gives less than 2 per cent. of the whole number as eligible for pensions, while the actual number of pensioners at the end of 1894 was only three, and the total amount of pensions paid, as per the Dolge statement dated 1894, is only $7,172.56.

The Dolge workmen are paid day rates almost exclusively, though there are about fifty piece-workers in the piano-hammer department. Mr. Dolge declares himself wholly opposed to piece-work and to any cutting of day-rates, and is a firm believer in high protection and high wages.

TABLES OF COMPARATIVE EARNINGS PER YEAR IN DOLLARS.

(Published in 1889.)

		No. 1	No. 2	No. 3	No. 4
	Dolge.	Mass.	England.	France.	Germany.
Hours' work per week....	59	60	56	72	76
Wool carders.....	684	422	360	231	200
Fullers	474	367	276	174	145
Finishers.....	450	376	312	225	140
Hammer coverers.....	708	...	...	...	...
Machinists	738	671	324	260	175
Dyers.....	474	442	264	225	147
Wool sorters.....	490	461	288	231	160
Laborers.....	423	429	240	210	145
MECHANICS. AVERAGE YEARLY EARNINGS.					
Plumbers.....$600					
Carpenters..... 450					
Shoemakers..... 555					
Cutters..... 480					
M'ch. hands..... 477					
Gluers..... 519					
Turners..... 675	Average.	550	517	320	245	195
Tool makers..... 660					
Moulders..... 562					
Sawyers..... 525					
Cabinet makers .. 543					
6,046					

1.—Report of Carroll D. Wright, commissioner of labor, 1881.

2.—Report of parliament, 1883.

3.—Report of United States Consul-General Walker.

4.—Report of United States Consul Dubois, 1881.

These tables show that the wages in the Dolgeville factories are 15 per cent. higher than those paid in the Massachusetts factories, 79 per cent. higher than those paid in the English factories, 138 per cent. higher than those paid in the French, and 227 per cent. higher than those paid in the German factories.

The average hour pay is under 20 cents per hour, and the tool-maker's pay is only 21 cents per hour against the 27-30 cents rate paid machinists at Midvale: but I think the Dolge tool-makers should not rank much above the Whitin machinists, whose hour rate is about 16½ to 17 cents. The factory uses no women workers. Living expenses are not much higher at Dolgeville than at Whitinsville or South Manchester, and not nearly so high as at Stamford or Philadelphia, which makes the Dolge hour rates virtually higher than they appear, because of increased purchasing power. No shorter statement of the Dolge system seems possible than that here appended, which is taken from a pamphlet, dated 1896, entitled "The Plan of Earnings Division."

"The name of every male person employed by Alfred Dolge & Son is placed at entry upon a register which shows nativity, date of birth, date of entry, age, department of the business in which he entered, transfer, if any, from one department to another, giving date of such transfer, date of voluntarily quitting employ, with reason therefor if known, or discharge by the firm, with record of the cause therefor.

"On December 31 of each calendar year the employees of that date whose names appear upon this register recorded prior to July 1 of that year, and the names thereon recorded between July 1 and December 31 of the preceding year, are placed upon the record book of the earnings division account, accredited to the department in which they are employed. The record book made up at this date shows the wages of each employee thereon enrolled for the year just closed and the amount to be paid thereon by each department of the business to the earnings division fund, on account of contributions thereto for pension fund, deposit fund, endowment fund, or life insurance expense. The basis of contribution to pension fund is 1 per cent. upon the amount of wages enrolled on record book December 31 of each year, which amounts are charged by each department respectively to its manufacturing expense account for that year.

"The contribution to endowment fund is made by each department in accordance with the manufacturing record therein, for the benefit of entitled employees to their individual credit in the earnings division account, and charged by the several departments to their manufacturing labor account.

"The contribution to 'deposit fund' is made by each department for the benefit of entitled employees under the 'insurance' provision, to their individual credit in the earnings division account for payment at maturity, and charged to its manufacturing expense account for the year. Life insurance policies are purchased (twenty payment life) and maintained during the time the recipient remains in the employ of Alfred Dolge & Son, the premiums being paid by each department and charged to manufacturing expense account. The insurance policies are in possession of, and remain the property of, the recipients after quitting employ of the firm, the holder having choice of a paid-up policy of as many twentieths as are years paid, or of continuing the payments himself to maturity.

"To the amount of each of the several funds is added semi-annually interest at the rate of six per cent. per annum, to the credit of the pension fund at large and the individual recipients under endowment and deposit accounts, in accordance with the terms respecting these funds.

"The benefits accruing to employees are conditioned upon a term

of continuous employment by Alfred Dolge & Son. In case of voluntarily quitting employ, or of having been discharged and re-entering the employ of the firm, the beginning of the term is the last date of re-entry. The twenty-first birthday of minors who enter the employ of the firm shall be deemed the date of entry for such employee.

"All and every one of the provisions under which benefits are conferred are entirely voluntary on the part of Alfred Dolge & Son, and no obligation or liability is created in favor of any employee either at law or equity.

"Every employee on the roll of earnings division who is over twenty-one and not over fifty years of age on the day of entry shall, after a continuous service of ten years, be provided, in case of partial or total inability to work, caused by accident, sickness, or old age, as long as such inability may last, the following proportion of the wages earned during the last year next preceding the accident, sickness or old age the cause of inability.

After 10 years' continuous service, - -	50 per cent.
After 13 years' continuous service, - -	60 per cent.
After 16 years' continuous service, - -	70 per cent.
After 19 years' continuous service, - -	80 per cent.
After 22 years' continuous service, - -	90 per cent.
After 25 years' continuous service, - -	100 per cent.

"At any time previous to the completion of ten years' continuous service, in case of accident while on duty in the service of Alfred Dolge & Son, or of sickness contracted through the performance of such duty, such employee shall be entitled to receive a pension equal to fifty per cent. of the wages earned by him during the year preceding such accident or disability.

"Employees who draw salary or earn wages to the amount of one thousand dollars or more per year, in case of partial or total inability to work, caused by accident, sickness, or old age, as long as such inability may last, are provided for as follows:

After 13 to 16 years of service, - -	$600 per year.
From 16 to 19 years of service, - -	700 per year.
From 19 to 22 years of service, - -	800 per year.
From 22 to 25 years of service, - -	900 per year.

"After twenty-five years of continuous service not exceeding $1,000 per year.

"As the pension is an equivalent for lost wages, the benefit is strictly personal, and not transferable under any circumstances.

"In case of partial loss of wages, where earnings are not cut off entirely, but only reduced, the pension is computed on the difference of wages only, representing the loss actually sustained.

"Employees of Alfred Dolge & Son entering the services thereof at or under the age of twenty-one shall, after five years of continuous service, at the age of twenty-six, receive a first policy of life insurance of $1,000; after ten years of continuous service, at the age of thirty-one, a second policy of $1,000; after fifteen years of continuous service, at the age of thirty-six, a third policy of $1,000.

"Entering the service thereof at any time between twenty-two and twenty-five years of age inclusive, shall, after five years of continuous service, receive a first policy of life insurance of $1,000; after ten years of continuous service, a second policy of $1,000; after fifteen years of continuous service, a third policy of $1,000.

"Entering the service thereof at any time between twenty-six and thirty years of age inclusive, shall, after five years of continuous service, receive a first policy of life insurance for $1,000; after ten years of continuous service, a second policy of $1,000.

"Entering the service thereof at any time between thirty-one and thirty-five years of age inclusive, shall, after five years of continuous service, receive a policy of life insurance for $1,000.

"Every employee entering the service thereof at the age of thirty-six years or over that age shall after completing five years' continuous service, have deposited, invested, or set aside by Alfred Dolge & Son, annually at the expiration of each and every additional year of continuous service thereafter, the sum of $35 for not exceeding twenty consecutive years of additional service. The aggregate of the deposit, including the interest accumulating thereon, if invested on interest, shall not, in any event, however, exceed the amount of $1,000.

"Every employee entitled to policy or policies of life insurance whose application to the life insurance company for such insurance is rejected shall have deposited or set aside annually, at the expiration of each additional year of continuous service of such employee, an amount equal to the annual premium upon the life insurance policy or policies with which he would have been provided except for such rejection. The aggregate of the deposit in lieu of life insurance, including the interest accumulations thereon, if invested on interest, shall not exceed in amount the face value of the policy or policies with which such employee would have been provided.

"In case of the death of an employee, the amount so deposited, invested, or set aside on behalf of such employee, with the accumulations of interest thereon, if invested on interest, shall, within sixty days after proof of death, which proof of death shall be made out upon blanks, in the form and by the persons as required by Alfred Dolge & Son, be paid over to the heirs or representatives of such employee. The interest on all such sums so deposited, invested, or

set aside shall cease from the day on which such employee leaves the employ or is discharged therefrom.

"Every male employee of Alfred Dolge & Son over twenty-one years of age, and who has been in their employ for five consecutive years, shall be entitled to an Endowment Account.

"At the end of each year so much shall be credited to this account as, according to the manufacturing record kept by Alfred Dolge & Son, is demonstrated he has produced more for Alfred Dolge & Son than has been paid to him in the form of wages. If, by neglect or carelessness, he has caused a loss, as appears from the manufacturing record, the same is charged against such employee on this same account. Upon any balance in his favor at the end of every such year of service, he shall be entitled to interest at the rate of six per cent. per annum, interest to be credited at the end of each year, but the interest thereon will cease from the day he leaves the employ or is discharged.

"This endowment money shall be payable to such employee only on his arriving at the age of sixty years, or, upon his death before that time, to his legal heirs or representatives.

"Nothing in any of the provisions for benefit under the earnings division system impairs the right of any employee to quit the employ of Alfred Dolge & Son at any time and for any cause or reason, or the right of Alfred Dolge & Son to discharge any employee at any time and for any cause or reason."

Tables given in the continuation of this pamphlet show clearly that one per cent. of wages paid will more than cover the cost of pension and life insurance, under the rules and limitations adopted at Dolgeville.

The "endowment" is a gift, pure and simple, although it is based on a system of careful departmental book-keeping, but, when, from any cause, profits decrease below a certain figure, the "endowment" is suspended, although the workman is in no way responsible.

At the "Reunion" of January, 1896, Alfred Dolge said:

"At our last Reunion I stated that my system of labor pension and insurance had passed the experimental stage; that a practical test of twenty years had proved the correctness of the theory underlying the system,—namely, that the employer not only could well afford to pay one per cent. of the wage fund toward labor pension and insurance, just as he pays annually from five to ten per cent. for wear and tear of his machinery, but that it is an excellent investment from a purely business point of view, and that this system could be nationalized so that each wage-earner could derive the benefit of the same without being hampered in his movements.

"England gave the world the factory system, and with it the fac-

tory slave. America should give the world the emancipation of the toiler from the wage system as founded by the Manchester school; in other words, the highest forms of corporations founded upon co-operation of brain and brawn in a mutually satisfactory relationship. This can be accomplished by the introduction of a labor pension and insurance system, and by no other means."

The Dolge holdings to day comprise a large number of patents on very valuable inventions; the extensive Dolgeville factories, employing, when full, about 1,200 hands; 45,000 acres of valuable timber lands in Herkimer, Fulton, and Hamilton counties; and almost unlimited water power. The firm looks forward confidently to a maximum of not less than 5,000 employees, when all of its great natural resources shall have been fully developed.

Despite Alfred Dolge's earnest repudiation of paternalism, it is difficult to see where his treatment of labor differs in results from that of Whitinsville or South Manchester. Pure air, pure water, excellent drainage, beautiful surroundings, fine schools, and cheap living, although there are no tenements owned by the firm in Dolgeville, are potent factors in the success of the three places alike. The life insurance and the pensions of Dolgeville cost no more, perhaps, per workman employed, than the unrecorded benefactions of the Whitin and Cheney management. It is, of course, a far more independent affair for the workman, if he enters service under a general system of established laws than if he depends solely on the final good will of his employer, but it matters little in final averaging of labor cost, whether the superannuated workman be pensioned, or kept on so long as he can crawl to the scene of his daily efforts for a lifetime of years. At Midvale the death of a workman brings his heirs $600 in the form of a 50-cent assessment on each employee, to which the management adds $250 in case of five years' service of the decedent; and the workman who has been inside the gates but a single hour is insured for $600, while at Dolgeville five years of continuous service and the age of 26 years are conditions preceding life insurance benefits, in no case exceeding $1,000 on one risk.

The Dolgeville "endowment" is as purely "paternal" as any gift of father to meritorious son could be, and is a variable, liable to sink to zero for successive years.

Yet, all in all, the Dolge system is a true system, inasmuch as it is formulated, and has proved successful in practice for twenty-two years, and, although each year does not end the liabilities, which are moral obligations on the management, it puts the relation between employer and employed more nearly on a footing of dollars and cents than do the Whitin and Cheney methods.

FOUNDATION CONSTRUCTION FOR TALL BUILDINGS.

By Charles Sooysmith.

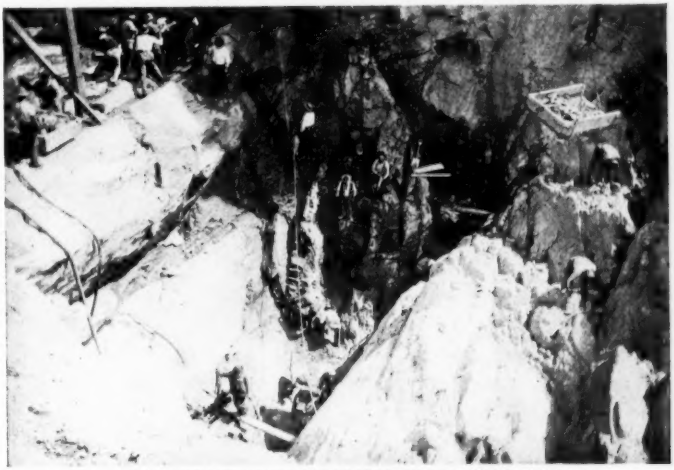
IF the extreme height of the modern office-buildings awakens our wonder and comment, we may also note with amazement the distance from which many of them spring from beneath the surface.

Indeed, great as was the stride upward which was taken when the first of them was built in New York city, the proportional increase of depth of some of their foundations is even greater. For instance, one of the buildings,—that of the Washington Life Insurance Company, soon to be commenced at the corner of Broadway and Liberty street —will rest upon rock seventy-five feet below the street surface.

The great increase in the height of buildings came very quickly with the visible possibilities of high-speed elevators and steel-frame construction, but the corresponding and necessary change in the character of, and the method of obtaining, suitable foundations developed much more slowly. Stories were added to the height because they would increase revenue, but old foundation methods, with few exceptions, were adhered to until absolute insecurity threatened.

Chicago is credited with being the birthplace of the modern office-building, and it was there that the use of steel beams to spread the bearing at the base (the first material departure from old methods) first came into use. In the old style of construction, which, for a building of only a few stories, called for walls thick at the ground level, it was easy and natural to get the area of base necessary to reduce the pressure on the soil to a safe amount per square foot by simply widening out the base of the wall by off-sets, making them of brick, stone, or concrete. In Chicago the clay on which the city is built is comparatively hard and firm above the level of the water in the lake, but below this level it becomes much softer, its power of resistance being insufficient to prevent it from yielding continuously under loads of three or four tons per square foot or even less. To keep the load within one and one-half to two tons per square foot,—which has been considered safe practice there,—the architects commenced, ten or fifteen years ago, to found their walls and columns upon bases of concrete, strengthened by layers, at first of railroad rails and later of "I" beams, employing these in order to spread the base without penetrating the softer clay below the hard top, thus, as it is now called, floating the foundations on grillages of steel beams.

Just as the architect with proper artistic feeling studies his building from both far and near, its roof line and the general sky-line about it, so there are many points of view from which the engineer must study the problem of proper foundations for a given building. He should first know the character of the site,—that is, the nature of the material beneath the lot to be occupied by the building. This can be readily ascertained by borings made by one of the inexpensive methods. In some important cases of very heavy loading it may be wise to determine, by one or more borings with diamond drills, whether supposed bed-rock be not boulders or a thin stratum underlaid by another of dangerously soft character; but this is seldom necessary. The natural water-level should be ascertained, not by a single observation, but by one or more pits in which the water is allowed to stand, that its level may be measured during as long a period as practicable, and care should be taken that there be no temporary local circumstances, such as a leaky pipe or drain, or inflow of rain, to make the measured level abnormally high or low. Often excavations in the vicinity, or pumping from a driven well, may, for the time being, materially lower the water-level. The great importance of knowing what can be relied upon as the true and permanent water-level is obvious when piles or steel beams are to be used in the foundations, for piles generally begin to decay in a few years, unless submerged, and it is a difficult thing, to say the least, to so protect steel beams as to secure them against



A DEEP FOUNDATION AT THE CATHEDRAL OF ST. JOHN THE DIVINE.
Looking down into rock excavation 55 ft. below the surface. Cleaning rock preparatory to laying concrete.

FOUNDATION WORK FOR THE CATHEDRAL OF ST. JOHN THE DIVINE.
A deep rock excavation, with rotten over-lying rock removed.

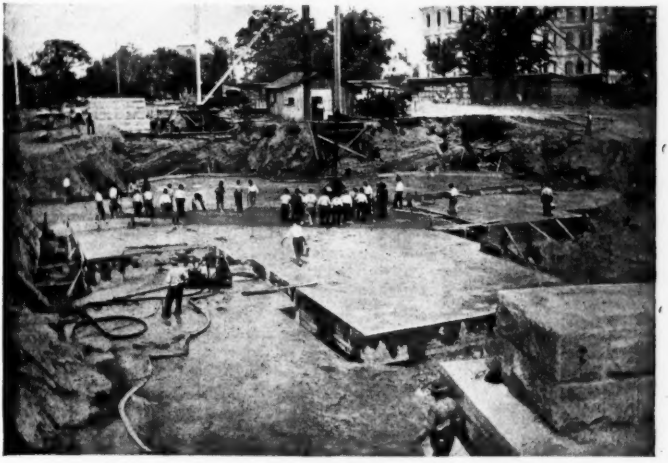
corrosion when submerged. The piles should never be used, unless they are to be continuously and certainly below water-level, and steel beams should be placed only where they will or may be submerged when there is an important engineering or economical reason for it. In any case the most approved methods should be employed to protect them from rust.

If, because of the excessive depth of an unyielding stratum, or for economical reasons, the building must rest upon a soft material, such as mud or fine wet sand, the possibility that this may find lateral escape from the load above it must be considered; for the material settlement of a building, where not caused by compression of the underlying earth, is to be explained in the majority of cases by either a general disturbance of the mobile material of the neighborhood, or a movement in response to lateral relief by deep excavation carelessly done near by. It is undoubtedly true that in such cities as Chicago and New York the jars from heavy trucks passing on the paving blocks are so many blows, each adding its infinitesimal increment to the readjustment of particles of earth, whenever made space in the neighborhood renders readjustment possible. The potency of these wheel-blows can hardly be questioned, when one notices the vibrations they often cause in the highest and heaviest buildings. When we think of the glacial movement of great masses of solid ice, it seems reasonable to look for a somewhat analogous, though, of course, slower, general

movement of soft material when unequally loaded and subject to changing conditions of drainage, loading, and shock. There are parts of some cities where the land for some distance back from river-banks has a movement riverwards measurable even in a short period.

The foregoing remarks about the unrest of the soft strata on which many of our cities are built are made in order to draw attention to general conditions that frequently exist and are wholly overlooked. They may be ignored in light and inexpensive structures. For economical reasons they cannot be guarded against in the majority of the larger buildings. But in the extremely heavy and costly ones they should be taken into account, lest a foundation otherwise ample should be unsuitable because of influences affecting the earth on which it rests. In fact, the chief problem to solve in designing foundations for most of our high structures in lower New York and in many other places is not to get a sufficient resistance to settlement under the conditions existing, but to so build that extraneous influences from other constructions or operations shall not render the support insecure.

With the data in hand as to water-level, nature of strata beneath the site, surrounding conditions, and the loads to be carried, the architect or engineer can proceed to the design of his foundations. If there is a firm stratum at slight depth, it is necessary only to excavate to this and provide a base for the columns either by masonry or gril-



PART OF THE FOUNDATION, CATHEDRAL OF ST. JOHN THE DIVINE.

This concrete base, about 20 ft. thick, will carry one of the four great tower-piers. The surface as shown is at the level of the crypt floor.

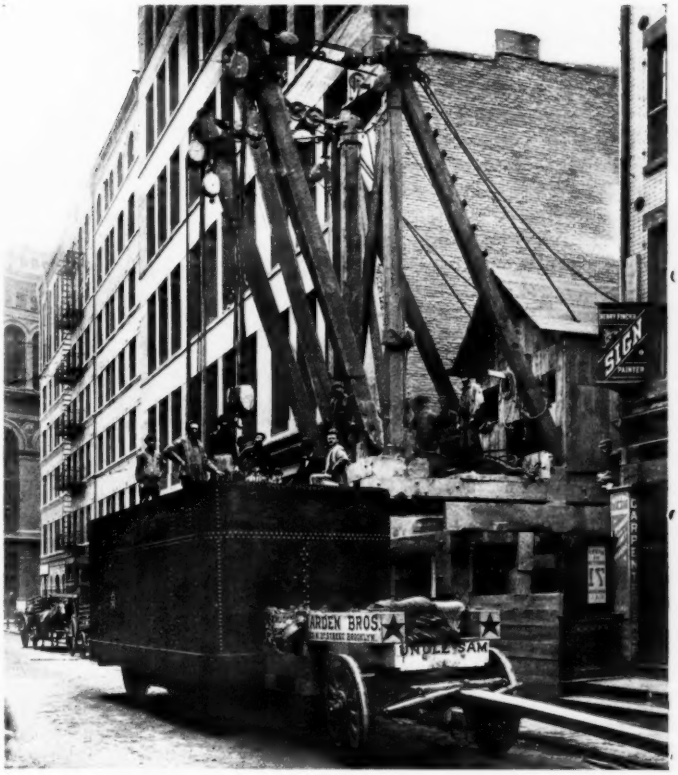
lage of steel-beams affording sufficient area to reduce the load per square foot to a safe amount. This, of course, will depend upon the nature of the material beneath. On the clay of Chicago it is unwise to have the load exceed one and a half or at most two tons, and even then a certain amount of settlement is inevitable, due to compression or squeezing out of the water in the clay beneath; the architect there thinks that a great deal is accomplished when the ratio of load of each part of his building to the corresponding support is such that all parts of the structure settle uniformly, and the uniformity of the clay in nature and depth are such that this has not been difficult. Apart from the objectionable cracks that would come with unequal settlement, the arrangement of beams, braces, and partitions in a steel frame building might easily result in a dangerous concentration of strain on some members, if others were relieved by unequal settlement.

In New York the steel grillages are sometimes laid directly on rock, in order to avoid occupying valuable cellar-space with large pedestals of masonry.

Where the water-level is such that they will remain submerged, and when it is practicable to drive them properly, piles make a most excellent and cheap foundation for buildings that will not load them, either separately or collectively, beyond the amounts usual in good practice. But the error should not be made—as it unfortunately has been in some conspicuous instances—of assuming that the total bearing-capacity of a large number of piles driven closely together is equal to the sum of their individual carrying-powers. The small piles often used and driven closely together amount in many cases to little more than replacing so much earth with an equal volume of piles, and these very often broomed up on the bottom.

When the underlying strata are of soft or comparatively soft material, such as prevails in Chicago, or of fine silt and sand, like that which exists for from forty to more than eighty feet beneath the surface in lower New York, the architect is practically limited to one of three plans for his foundations: either to float them on a steel grillage, or to put them on piles, or to sink them, by means of cylinders or caissons, to bed-rock or hard-pan.

In the case of the Manhattan Life Building in New York,—the first of the very high office-buildings where the caisson method was resorted to,—the architects, Messrs. Kimball & Thompson, found that enough piles could not be driven in the lot to properly support the loads, and that to float the building on grillages was out of the question, because of the danger that the soft material beneath would escape laterally under its great load. To make open excavations to the bed rock, some fifty-four feet beneath the street surface, was not safe, if

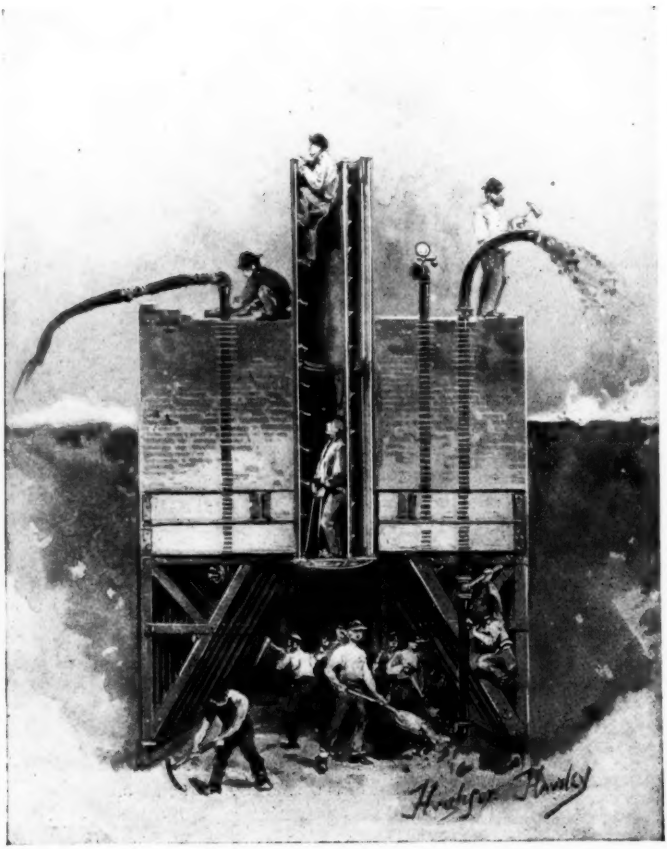


A CAISSON DELIVERED COMPLETE, READY FOR SINKING.

The one shown, used in the Standard Oil Building, weighed about 38,000 lbs.

possible, because of the danger of undermining adjacent buildings. To obviate all this, it was decided to sink steel caissons by the pneumatic process, as is done in obtaining foundations for most of the great bridges. Thus was inaugurated, four years ago, the caisson method now coming into extensive use for buildings.

A pneumatic caisson is simply a diving-bell, on top of which the pier or foundation-structure is built. It consists usually of a rectangular or round box made of boiler-plate steel. It is seven or eight feet high and without bottom, and of length and breadth in accordance with the size of foundation-pier required. After being set in position



CROSS-SECTION OF A CAISSON.

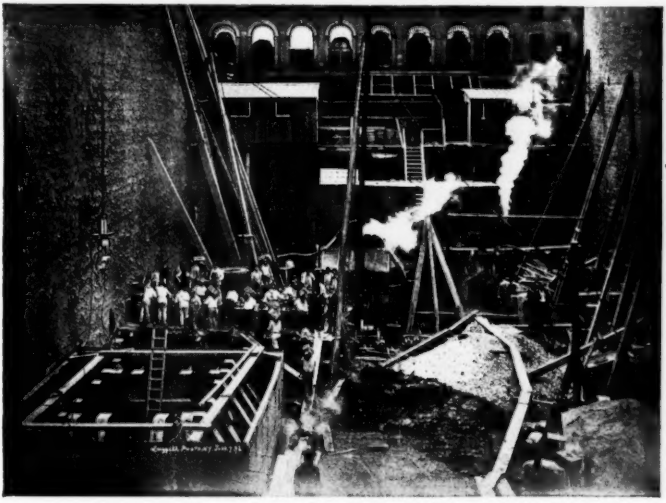
Showing working chamber, air-lock, and method of "blowing" material.

on the lot, the construction of the brick or concrete pier upon its roof is commenced. A passage-way through this latter and the roof of the caisson is provided by means of an iron tube, usually three feet in diameter. This is closed by means of an immense double valve, or air-lock. Men enter the caisson beneath the pier and commence undermining it, the material being hoisted out through the tube. When the water-level is reached and the excavators are troubled by the gradual

entrance of the water into the working-chamber of the caisson, air is blown in through a pipe. This air is supplied by powerful steam air-pumps, and its pressure holds the water down to a level with the bottom or cutting-edge of the caisson. The men and the excavated material can pass through the tube without relieving the air-pressure, because the air-lock has two doors, only one being opened at a time, and the pressure between them being regulated slowly, to avoid injury to the workman by the sudden transition to or from the compressed air.

The operation of undermining the caisson and building upon it is continued, until the cutting-edge reaches bed-rock. This latter is then cleaned, and, if sloping, is stepped off; then the entire chamber is filled solidly with concrete. The pier, then, consists, first, of the concrete base or filling of the caisson surrounded by the walls of the working-chamber; next, above this, and forming part of the permanent work, the metal roof, a fraction of an inch thick, of the caisson; and, above this, the pier proper, of brick or concrete.

The speed of building the foundations in this way is much increased by the fact that, while the excavation is being made, the pier itself is being built, so that it is actually finished within a few hours after the

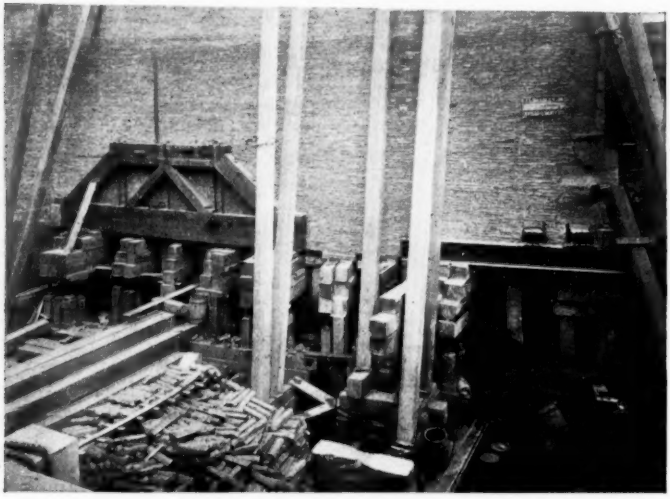


CAISSON BEFORE ROOF-PLATES ARE ATTACHED, SHOWING POSITION OF BRACKETS.

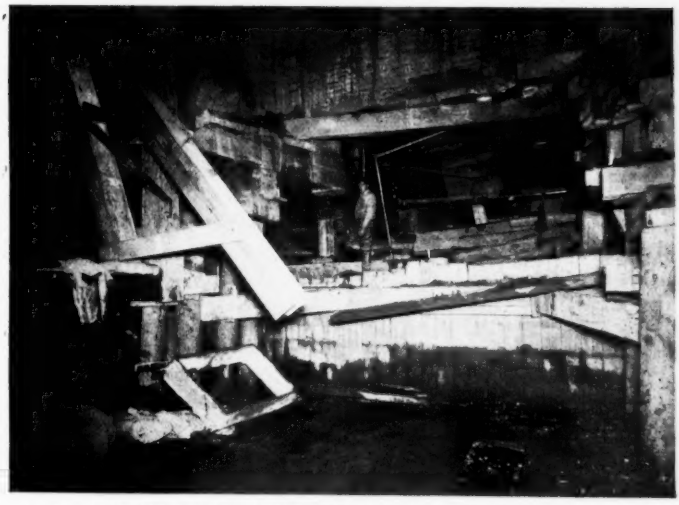
Brick-layers at work on another caisson, building brick-work preparatory to sinking, Manhattan Life Building.

excavation is completed. The weight of the masonry and metal, and additional temporary load when needed, force the caisson down against the upward pressure of the air against its roof, and, when properly conducted, the sinking results simply in pressing an immense plug into a passage-way cut for it through the earth to the bed-rock, thus permitting no flow of material into the excavation to endanger the support of the adjacent buildings.

The cellar-floors of the new buildings are almost invariably placed at a lower level than the foundations of the older buildings adjoining, and for this reason, if for no other, it has been the custom to shore the adjoining building. The favorite method of doing this now is to cut notches in the wall, and in these to sink pipes built up of sections screwed on as sunk, taking the weight of the building on these pipes. In the case of the great building about to be put up facing Trinity Church at Broadway and Rector street, the adjoining building is being thus supported before the buildings to be torn down are removed. Some very valuable time will be saved in this way. The work is done from the basement of the building to be removed, without disturbance to anyone, by cutting openings through the walls of the building to be removed and opposite to each of the notches in which pipes are being sunk under the adjoining building. In some cases it may prove eco-



SHORING SCHERMERHORN BUILDING DURING CONSTRUCTION OF AMERICAN SURETY BUILDING.



SHOWING METHOD OF SHORING AND SHEATHING FOR UNDERPINNING. STANDARD OIL BUILDING.

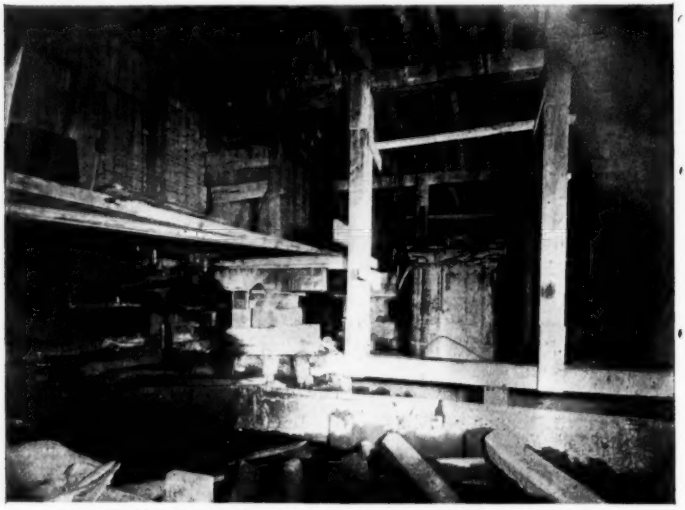
nomical and entirely feasible to build the foundations for a new building before removing the old buildings. When tenants of the old building cannot be induced to give up their leases on reasonable terms before the end of the regular term,—in New York the first of May,—such a procedure might enable a new building to be completed by the beginning of the next rental year.

The time required now to build the foundations for a large building by the caisson method is from two to three months, but this time will doubtless be lessened with increased experience.

Cylinders, within which to build foundation-piers for buildings, have been sunk without the use of compressed air, by simply loading them and easing up the friction and resistance by jets of water. This method has very great limitations, and, because of the liability of endangering near-by buildings by disturbance of the material, and of the uncertainty of getting the cylinders to the proper position and depth, so that they can be cleaned out and the foundation well built, the method seems likely to be used only when the conditions are particularly adapted to it.

It is probable that in some cases, rather than sink isolated caissons, or rows of them, it would be better to sink one or more caissons to cover the entire lot, not filling these with masonry, but using them

merely as shells or coffer-dams, by which the exterior walls of the building and its columns could be carried downward to the rock and the entire space utilized for stories below ground. The walls of the caissons may become the walls of the building, in part or wholly, and its roof may be one of the floors. With ample fresh air brought by flues from the roof of the building; with white tile finish and electric light; with absence of the usual basement masses of masonry, since the columns themselves would be carried down; and with the elevators running down to them,—I believe that for safety-vaults, restaurants, barber shops, etc., the rental of such stories would, on the most valuable sites, pay a fair return on the cost of the entire foundations. In



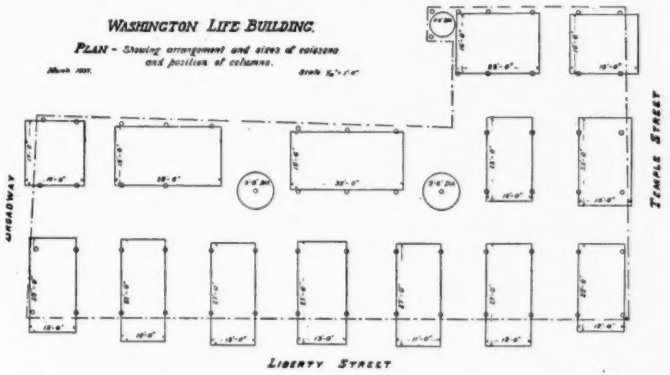
VIEW UNDERNEATH WORKING PLATFORM. STANDARD OIL BUILDING.

this craze for high building, when we contemplate the possibilities of having ere long to go the country or the roof to find out if the sun shines, is it not time to make this plea for additional depth rather than increased height.

It is the great misfortune of the sub-structure engineer that his work is not in evidence. He may build well, but he must bury his work, and, unless the space be utilized as just suggested, the money he spends brings no apparent revenue. Hence, doubtless, the hesitation of many owners to go to the expense of supporting their buildings on a rigid foundation; and yet the cost of this, as compared with that of the cheapest possible foundation, generally would not exceed it by 5

per cent., and seldom, if ever, by 10 per cent., of the cost of the building. To offset this there would be in most cases reduced cost of repairs from cracking of plaster, settlements, etc., a longer life of the structure, and in New York city the consequently higher rental value. In an advertisement of the highest office-building in the city it was lately set forth in large type that the building stands on solid bed-rock, whereas in reality it is floated on fine sand, and has been provided with an ingenious arrangement by which any of its columns can be lifted and shimmed up by means of hydraulic jacks inserted in the pedestals beneath the columns.

The investor who builds a great building to-day must bear in mind that we cannot expect these twenty-story buildings to be out-grown in


WASHINGTON LIFE BUILDING.
PLAN - Showing arrangement and sizes of caissons and position of columns.
BROADWAY
TEMPLE STREET
LIBERTY STREET

DRAWING SHOWING SIZES OF CAISSONS AND POSITION OF COLUMNS FOR PROPOSED WASHINGTON LIFE BUILDING.

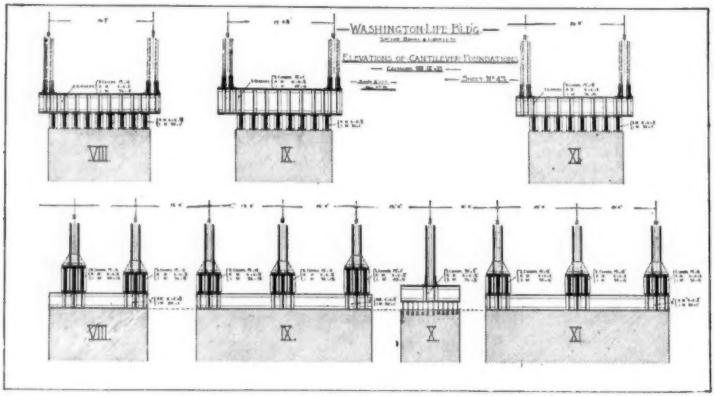
C. L. W. Eidlitz, Architect.

a few years, as the four- or five-story buildings have been. They should be built to last; the steel and wood, when hidden, should be protected from decay; and the metal and masonry should not be overstrained. He should also remember what the value of the structure may be ten, twenty, or thirty years hence, and what its reputation is likely to be in the light of that day's knowledge of high buildings. A structure just finished may have defects which seem of little commercial consequence now, because serious consequences from them are twenty, thirty, or forty years off. Ten or twenty years hence they may be visibly impending. As yet there have been no disasters or conspicuous failures of any of the finished high buildings; doubtless in the main they have been too well built for us to anticipate any; and, happily for static conditions, the factors of safety have very large margins.

Yet it is more than possible that some one or few, through faulty design or careless or dishonest construction, may fail; and, whether the particular imperfection causing the failure be quick-sand under the building, rust or over-strain of some of its members, or something else, the value of every structure having the same possibility will be materially affected. If a single one of the prominent new buildings on a floating foundation were to threaten to give way, the selling value of every large structure in the city on a similar foundation would decrease to an extent far greater than the sum it would have cost originally to support it on a trustworthy stratum.

This plea for the building of the best foundations is made to owners, who are the ones who need to be reminded of their interest in them. The architect will, as a rule, be only too glad to have them, but he is generally under injunctions of economy, and, unless encouraged by a proper attitude on the part of the owner, will often hesitate to urge the outlay necessary to provide foundations in keeping with the weight and cost of his building.

As the statutes now stand in New York city, the builder of a new edifice has to protect from settlement the adjoining buildings, when the latter have foundations more than ten feet below the street level. This has been fair enough in the past, but during the last few years many very heavy buildings have been erected on shallow foundations with fine sand, in some places practically quick-sand, beneath them. This has been put under so great pressure, and under such a tendency to seek lateral escape, that the owner of an adjoining lot, when he



ELEVATION OF PART OF A CAISSON FOUNDATION.

Showing arrangement of cantilevers and position of steel columns on the foundation piers. Proposed Washington Life Building, New York.

wishes to build, must either limit himself to a shallow foundation, which may mean a permanent improvement inadequate to the site, or meet the risk and heavy cost of protecting, by underpinning or otherwise, his neighbor's building. The law should be amended; either the excessive over-loading of the soil at slight depths should be prohibited, or the adjoining owners should be relieved from liability for settlements caused in carrying out with reasonable care the excavations necessary in improving their property.

The evolution of the new type of business buildings has been startlingly rapid. Probably the further advances to be made will not be in the direction of greater height, but in that of improved structural character and true economy of design. That greater attention to the matter of foundations is now a marked feature is shown by the fact that, of the six high office-buildings to be built the coming season in lower Broadway, four are to have caisson foundations sunk to the rock by the pneumatic process, and foundations of the same kind are to be used in the new custom house in Chicago.

(The illustrations of the work on the foundations of the Cathedral of St. John the Divine are used by the courtesy of the architects, Messrs. Heins & La Farge.)

AMERICAN AND BRITISH BLAST-FURNACE PRACTICE.

By J. Stephen Jeans.

I. THE GROWTH OF THE SYSTEM OF INTENSIFIED PRODUCTION.

IN the checkered and eventful history of the iron industry, there is no record or movement of greater economic importance than that which, during the last thirty years, has in most cases trebled, and in many others has more than quadrupled, the output of blast-furnace plants in nearly all the leading metallurgical countries of the world. This movement, which is still in progress, and likely to lead to even more remarkable results than those hitherto recorded, naturally is occupying the minds of pig-iron makers in all countries alike. Indeed, it may truthfully be stated that no subject connected with that industry is at present more in the thoughts of blast-furnace owners than that of how far they should proceed in the direction of rivaling the great yields that have been achieved by a few of the leading firms in the United States, and by a smaller number in Great Britain and Germany.

Before proceeding to consider the conditions under which the record yields of the United States and European countries have been achieved, it is desirable that we should have before us a few historical facts relative to the actual results hitherto arrived at in some of the European countries that are entitled to be regarded as competitors and rivals of each other and of the United States.

Dealing first with Great Britain as one of the oldest and most notable of iron-making countries in the past, it is hardly worth while to recall the conditions that prevailed a century ago, or, indeed, of any period prior to about thirty-five years ago. The blast furnaces of an earlier date were generally of so small dimensions, used so limited a pressure of blast, and were otherwise so at variance with the conditions that have given us the enormous yields of the present day, that they could hardly be regarded as in any sense the same sort of apparatus. Until the Cleveland district came to the front, about 1850, the ironworks of Great Britain, mostly located in Scotland, Staffordshire, and South Wales, had made but little progress since the commencement of the century, when the total make of pig iron in the kingdom was estimated at less than 150,000 tons. The furnaces as a rule, were open-topped, had a cubical capacity of less than 5,000 tons, and were considered to have done well, if they produced 3,000 to 4,000 tons

per annum. The introduction of the hot-blast by Neilson gave a stimulus to the pig-iron industry between 1840 and 1850, more especially in Scotland, where it originated; but it appears to have operated rather in the direction of reducing the previously large consumption of fuel than in that of bringing about better blast-furnace practice generally. Furnaces continued to be of small dimensions, the height seldom exceeding 40 feet, with a bosh ranging from 12 to 15 feet, and a cubical capacity of 3,000 to 5,000 feet.

While the older iron-making districts of Great Britain were producing, between 1840 and 1850, from two to three million tons of pig iron per annum in this sleepy and unprogressive fashion, the Cleveland district in North Yorkshire came to the front as an active competitor of the older and more conservative regions. For a time even the pioneers of the Cleveland iron industry had to move cautiously, and it is doubtful whether they were animated with any sort of assurance that they could do better than their competitors. At any rate, it was not until 1861 that any furnaces were built exceeding 8,000 feet in cubical capacity or 17 feet bosh. In that year Messrs. W. Whitwell & Co., of Thornaby, constructed three furnaces with a capacity of 12,178 cubic feet, a height of sixty feet, and a bosh of 20 feet. This plant at once gave much better results than any previously recorded, and, with the aid of the Whitwell hot-blast fire-brick stoves, which were soon afterward introduced by the late Mr. Thomas Whitwell and his brother, Mr. William Whitwell, these yields were considerably improved. The next most important departure in the same district was the erection in 1864, by the firm of Stevenson, Jaques & Co., of three furnaces with a cubical capacity of 17,000 feet, a height of 70 feet, and a bosh of 22 feet. Again the results of increased dimensions were successful, and hence, in 1867, the Norton Iron Company, near Stockton-on-Tees, was induced to build a plant of two furnaces, each with a cubical capacity of 26,000 cubic feet, a height of 95 feet, and a bosh of 25 feet. The progress here was rapid enough even for American practice, for within seven years the cubical capacity of the furnaces had been more than trebled, the height had been increased from about 60 to 95 feet, and the bosh had been increased by 8 feet. All this, of course, was more or less experimental, seeing that neither the Cleveland district or any other had at that time the experience required to give absolute proof that the experimenters were moving in the right direction; and naturally it was felt that there was a limit beyond which neither height or cubical capacity could be increased with advantage. It was generally believed that that limit had been reached, if not exceeded, in the case of the new furnaces built by the Norton Iron Company in 1867. Nevertheless, the boldness and enterprise of the ironmasters

of Cleveland did not stop even there. Three years later, the firm of Cochrane & Co. constructed two furnaces, each with a bosh of 30 feet, and a cubical capacity of 41,149 feet, while the Rosedale & Ferryhill Company erected two furnaces of 100 feet in height, and 50,000 feet capacity, being more than ten times the capacity of any furnaces built in Great Britain up to 1850.

It is from this date that the great makes of the blast furnaces both of the Cleveland and of other districts may be said to originate. Between 1866 and 1896, while most countries and most other districts were still lying on their oars and taking things easy, the Cleveland district, by the increased productive resources of each new plant added,—and in those days plants were run up quickly—was enabled to forge ahead of all others. In 1866 the average annual make per furnace in that district was 9,751 tons. In 1896 it had increased to 16,813 tons, being an increase of more than seventy per cent. over the make of ten years before, and in later years the make has risen to more than 30,000 tons per furnace, without any further increase of size. Indeed, it has been found, of recent years, that the exceptional dimensions attempted by Cochrane & Co., the Ferryhill Iron Company, and one or two other firms did not yield any corresponding advantage, and for a time there was a tendency to rather diminish than increase the size of the new blast furnaces built, both in Cleveland and in other districts. So far as the United Kingdom is concerned, the experience gained in Cleveland was applied in the still newer district commonly called the West Coast (which embraces North-West Lancashire and West Cumberland), where the height of the furnaces seldom exceeds 70 feet, and the capacity is usually under 30,000 cubic feet. British ironmasters have since realized what was discovered and acted upon at a much earlier date in the United States,—namely, that it is not mere size that enables large yields to be produced, but that a suitable size must go hand in hand with greater blast pressures and other conditions that constitute what is known in Europe as American practice.

It was on the West Coast that the furnaces in Great Britain first attained an average of more than 25,000 tons per furnace per annum; but this result was mainly owing to the richer ores made use of. Cumberland ore, at that time, was wholly used on the West Coast; such ore contains, on an average, more than fifty per cent. of metallic iron, as against about thirty in the ores of Cleveland. Even, however, with the rich ores of Cumberland, the West Coast furnaces in 1866 were not making more than 11,000 to 14,000 tons per furnace per annum,—a yield which ten years later had improved to between 16,000 and 18,500 tons. In no other district in the United King-

dom did the average annual yield per furnace in those years exceed 12,000 tons, and in most of the older districts—West and South Yorkshire, South Staffordshire, and Shropshire—the annual yield did not exceed 8,000 tons, even so recently as twenty years ago. At that time a feature of the British iron industry was the manufacture in South Wales of anthracite pig iron, which has since then been entirely discontinued. The make of such iron was never large, but in 1866 it was as much as 34,516 tons, being an annual average of only 3,138 tons per furnace in blast. About 1890 the last anthracite furnace in the United Kingdom was discontinued, although some iron makers are sanguine enough that, under more modern conditions, the industry might be resumed with advantage. It may here be added that there are still 119 anthracite blast furnaces in the United States, of which 40 were in blast on June 30, 1896, as compared with 56 at the end of December, 1895. If we take the average of December 31, 1895, and June 30, 1896, as representing the number of furnaces in blast during the intervening period,* it appears that the anthracite furnaces were making during that time at the rate of 28,500 tons per furnace per annum, while the bituminous coal (coke) furnaces in operation during the same period were making at the rate of about 60,000 tons per furnace. In the United States, therefore, as in Great Britain, the anthracite furnaces are far behind the bituminous standard, although, of course, American practice is far ahead of British in both categories.

The considerably larger quantity of material that has always had to be passed through the blast furnaces of Great Britain has, of course, been a sufficient explanation of the lower yields of the blast furnaces of that country, compared with those of the United States, and in all probability always will be so. Of the total consumption of iron ores in British blast furnaces in 1895, amounting to about 17,500,000 tons, about 7,000,000 tons were hematites of British origin or imported. The average richness of this latter ore does not exceed fifty per cent., and the average of the imported hematite is rather under that figure. On the other hand, the British blast furnaces have to consume a very considerable body of ores that average no more than thirty per cent. Such are the ores of Cleveland, Northamptonshire, Lincolnshire, Leicestershire, and North Staffordshire, amounting to an aggregate, in 1895, of about 9,000,000 tons, and equal to the production of about 3,000,000 tons of pig iron. The latter give conditions more nearly identical with those of Alabama than with those of any other district in the United States, and should, therefore, be compared with the re-

*In the United States there do not appear to be any official statistics of the *average* number of furnaces in blast during a period.

sults of blast-furnace working in that State, if compared at all. Even so, however, American practice leaves that of Great Britain far behind. The average output of the furnaces in blast in Alabama during the first half of 1896 was 21,150 tons, which is equal to an annual output of 42,300 tons per furnace. In the Cleveland district of Yorkshire, however, the average annual output per furnace in blast in 1895 was only 32,400 tons, although in this case the local ores are invariably calcined so as to produce about forty per cent. of iron in the furnace, while nearly one-half of the total quantity of iron now made in the Cleveland district is hematite, Spanish ores containing, on an average, almost fifty per cent. of iron. When we compare the outputs of furnaces using hematite ores exclusively, the results are much more favorable to American practice, as regards yields. The bituminous coal furnaces of Pennsylvania yielded in the first half of 1896 at a rate of about 60,000 tons a year per furnace, assuming the average number of furnaces in blast in the half year to be the mean of those recorded as blowing at each end of the period. In North-west Lancashire and Cumberland, which use almost exclusively bessemer ores, containing, on an average, more than fifty per cent. of iron, the average output per furnace in blast during the same half year indicated a rate of 32,000 tons per furnace per annum. Neither basis of comparison, therefore, shows the United Kingdom in a favorable aspect.

Before passing from this point, it is only proper to remark that some of the blast-furnace authorities of Great Britain have been inclined to dispute whether the large yields characteristic of American practice are, on the whole, an advantage. The argument is that hard driving tends to shorten the life of the furnace, and that the chief aim to be kept in view by the ironmaster is to get as large a yield as possible out of a furnace during its "campaign," whether that campaign be long or short. In other words, it is argued that, if a furnace producing, say, 60,000 tons a year, can give a total output of only, say, 200,000 tons before being relined, it is a more costly business than a furnace which gives, say, 220,000 tons in its life, although producing only 30,000 tons a year. The American system has been described in England as "a short life and a merry one." The English system, *ex hypothesi*, is to be regarded as a long life and a dull one. I do not here lay down any actual rules or facts; I merely state the drift of the argument. As a matter of fact, it is well known that record "campaigns" have been got under both systems, and, so far as I know, the facts do not justify the inference that a furnace producing a smaller annual yield will show a larger life's work than a furnace producing a greater annual yield, despite the relevancy, in some similar cases, of the well-worn aphorism, *festina lente!* There are not available, within

my knowledge, a sufficient number of examples to justify generalization on the point. But the difference from this point of view, whatever it may be, is not usually regarded as so important as the difference of joint cost of installation and labor costs. Regarding the former, I may point out that, in the United Kingdom, furnaces of the modern type known in the United States are few and far between. Only two concerns in Great Britain have hitherto attempted to build furnaces on American lines,—the Dowlais Iron Company in South Wales, and the Palmer's Iron and Shipbuilding Company in the north of England. In both cases the cost incurred is understood to have been far above the average. Indeed, in most of the older districts of Great Britain furnaces rarely cost more than £20,000, although in some of the more modern plants of the Cleveland district the cost exceeded £30,000. I have before me particulars of a plant recently erected at the Glengarnock Ironworks in Ayrshire (Scotland), where two furnaces were erected by Mr. Edgar Richards (eldest son of Mr. E. Windsor Richards, the respected past-president of the Iron and Steel Institute) for a trifle more than £14,000—this figure covering everything except the blast engines, which were already on the ground. I believe it will be interesting to give illustrations of these furnaces, which are in most respects the most modern hitherto adopted in Scotland.

The question of the cost of large blast-furnace yields has received a new impulse from the enterprising action recently taken by the Carnegie Company, in building at Duquesne four furnaces, costing, it is estimated, £150,000 each. These Duquesne furnaces have several unique features, as might be expected in a plant of such proportions. A friend who has recently examined the plant—which was not sufficiently advanced for examination when I was in the United States last year—informs me that each is 100 feet high, and has a 20-foot bosh, and a 12-foot well, with ten tuyeres, equipped with four Cowper stoves per furnace, while the distance between the furnaces is not less than 560 feet. These furnaces were designed to give an annual output of 182,500 tons each, and even this enormous rate of output has occasionally been exceeded. With this output a blast furnace costing £150,000 would yield 1.2 tons per pound of first cost per annum. In England a furnace costing £30,000 will seldom yield more than one ton of annual product per pound of capital expenditure, although, of course, in some cases they show better results. Up to this point, then, the advantage appears to be on the side of the higher-priced plant. But there are other considerations that enter into a calculation. The most important and obvious of these is the total capital expenditure incurred relatively to the total yield of iron obtained. If

the furnace which cost £150,000 is to give, as an alternate yield, during its complete life, five times the quantity of iron that would be got from a furnace costing only £30,000, the two would appear to be quits. If the more costly furnace gives less, then, measured merely by the standard of ultimate product, it would not be so economical. In the case of the Duquesne furnaces, however, as is generally known, a very large part of the high cost is incurred in providing appliances and means for economizing labor, and to such a point has this object been carried that both fillers and chargers are entirely dispensed with. Outlay thus incurred is, of course, well expended, although, at first blush, it looks so serious that none but the boldest and most wealthy would be likely to face it. In England, as in all pig-iron making countries, the results of the great experiment made by the Carnegie Company at Duquesne will be watched with interest, and it is quite on the cards that in the future it must be largely followed, if pig-iron makers are to be up-to-date.

So far as labor costs are concerned, I do not hesitate to declare that it is impossible to fix the proportions in which the expenditure for labor enters into the final cost of pig iron in any country or district, although, of course, it is otherwise with individual works. I make this statement unreservedly, despite the attempts made by many authorities on both sides of the Atlantic to compare costs in the United Kingdom and the United States. I do not know of any two works in Great Britain—and I am acquainted with the economic conditions of many—where the labor costs are the same. But I do know that, if—to take one or two instances—the labor costs of the Derwent Iron Works and the Moss Bay Works in West Cumberland, or of the Palmer Works on the Tyne and the Tudhol Works on the Wear, are compared, there will be material differences. I propose, however, to enter upon this important subject of labor costs in another article, and would, therefore, now add only that, while in the United Kingdom these costs range from 1*s.* 11*d.* per ton to 4*s.*, and in the United States from $1 to $2.50, it is practically impossible to arrive at a decision that shall be entirely free from attack from one side or another.

EPOCH-MAKING EVENTS IN ELECTRICITY.

By G. H. Stockbridge.

I. VOLTA—ELECTRICITY OF TENSION SUCCEEDED BY THAT OF MOTION.

WHETHER those who discovered the great facts of science or those who explained the facts and enunciated their pervading meaning in set laws have contributed more to the advancement of the arts that send men to softer beds, with easier muscles and wiser heads, would be an engrossing subject of study and speculation. One understands immediately the value of knowing the how and the wherefore. Without annulling the zest of inquiry, it steadies, fosters, regulates it by supplying the investigator with rational expectations of reward and awakening a just personal pride in success. On the other hand, there are great scientific discoveries or experiments which fire the brain like old wine or a noble poem. Such a discovery, associated with the name of Professor Röntgen, is fresh in the minds of us all. It set the whole scientific world to passing rays of light through substances we have been wont to call opaque. And not in play, either; for it is within the expectation of everyone that most beneficent inventions will date from this surprising discovery.

Such an event is to science like the discovery of the new world to stagnating Europe; and for a similar reason. For this new domain, too, is likely to be the shore of a new continent, or, at the very least, an outlying island, or the far and unknown side of the familiar Indies. In either case, it is a promise of work or adventure for those who wish them, homes for contented families, and fruitful fields for genius as well as for honest industry and capacity. These quickening presentiments of discovery, before science has begun to set her bounds and cordons, are among the most wonderful manifestations of human intuition; yet they generally prove to have been rational, and wise men build on them. If the first movement of the needle to the lodestone stimulates to wilder dreaming and larger prophecy than the soap-bubble, there is sure to be some sound and subtle reason for it. The Arabian Nights tales are, after all, truer than Mr. Howells's realism. In the broadest interpretation of science, they have a larger place and a completer justification. But the instinctive expectation of which we have been speaking regards not the principle of action in the thing discovered, but depends on the mere sentiment of science. It marks the poetic, the Arabian Nights period. The strictly intelligent pursuit of the subject begins when some philosopher has formulated the laws.

Lest this repeated allusion to the stories of Scheherazade should

seem somewhat too fantastical, let me say that the stories were, in all probability, written at a period when Arabia had newly experienced the awakening coming from just such a series of discoveries through contact with more advanced civilizations. The author simply abandons himself to the description of the physical possibilities suggested by his new knowledge. But it is fair to add that the unequalled interest which men have had in the marvellous accomplishments of those beings who, in the Thousand and One Nights, stand for power or active energy under human control is due to the fact that the world has recognized itself in them. Not in gratitude to one who relieves an irksome and tedious routine by picturing a pleasant unreality has the universal homage been paid to the author of these wonderful tales (we should be poor fools, indeed, to be cheated so palpably), but in loyalty to a spirit that had faith in human power, deserving, and destiny,—a spirit awakened, be it remembered, by the sudden revelation of things theretofore beyond its ken.

It is with a few of these imagination-stirring revelations or discoveries that the present brief series of papers has to deal. To all but the special student they may appear self-born, without progenitors, yet they have their own laws. One is sure that the major discoveries of science were not accidental. They were made by men on the lookout for them.

To be more specific, it is the purpose of this series of papers to call attention to three of the epoch-making discoveries in electricity and magnetism, and particularly to the literary records through which the knowledge of them was first published to the world. Starting with the idea of going back to the sources, as the Germans say, one may thus exhibit the science in its growing state; may make its significant facts and its real problems more apparent, and their true solution more clear, by showing how the facts appeared to their discoverers, and what the actual solutions of the problems were, as worked out by those who first succeeded. In general, then, in this series, there will be coupled with the disclosure of the original discovery some briefer or longer statement of the work of those who developed its laws. Further, it seems best to maintain, so far as possible, a certain unity, and this consideration leads to the determination to start with Volta's experiments with the "artificial electric organ" in the form of a "column" or a "crown of cups," and follow with Oersted's discovery of electro-magnetism and Arago's experiments with his rotating disk.

The first published disclosure of Alessandro Volta's marvellous discovery of current electricity was a letter, originally written in French, addressed to the Right Honorable Sir Joseph Banks, president of the

Royal Society, read before the Society at its meeting of June 26, 1800, and printed in the Philosophical Transactions for that year. Some ten years earlier Volta, who was professor of physics at Pavia, had travelled through France, Germany, Holland, and England, and become personally acquainted with their principal men of science. It was natural enough that he should communicate the first news of his great discovery to the British Royal Society, through its president. This disclosure marks the passing of science from the knowledge of animal electricity, and of electricity in a state of equilibrium or tension, to the knowledge of those phenomena of electricity which are a consequence of its motion, when the equilibrium has been destroyed. It was the starting-point of about all that we admire in the modern electrical arts. How immensely the scope of electrical adventure was broadened by Volta's work could be foreseen only dimly at the time. Volta himself simply said that such experiments "opened a wide field for speculation, particularly for the anatomist, the physiologist, and the practitioner." To one who arrived at his success through the study of animal electricity, this modest expectation was the natural one. But the mode of his progress is not to be forgotten. Volta was impelled to his own investigations by Galvani's earlier work. But, while Galvani appears to have regarded the nerves and muscles of the frog's-leg as the source of the electrical phenomena, and to have ended there, Volta finally discarded the animal tissues altogether, and after having examined the mutual action of metals and salts, he produced a genuine "electromotive apparatus," or electric generator, the forerunner of the modern electric battery.

The first form of his apparatus was a "column," which he describes as follows:—"I provide several dozens of little round plates or disks of copper, brass, or, rather, silver, an inch in diameter more or less (coins, for example), and an equal number of plates of tin, or, what is much better, of zinc, almost of the same shape and size. I say *almost*, because precision is not necessary, and, in general, the size, as well as the shape, of the metallic pieces is arbitrary. The only precaution necessary is that they be capable of being arranged conveniently one above the other in the form of a column. I prepare also a pretty large number of circular pieces of pasteboard, skin, or some other spongy matter capable of absorbing and retaining considerable water or moisture, with which they must be well saturated in order to insure the success of the experiments. These circular pieces or sections of pasteboard, which I shall call moistened disks, I make a little smaller than the metallic disks or plates, so that, when interposed between them, as I shall hereafter describe, they may not project beyond them.

"Having all these pieces at hand and in good condition,—that is to say, the metallic disks very clean and dry, and the non-metallic ones well saturated with common water, or—what is much better—with salt water, and wiped a little so that the moisture may not drop off, I have nothing to do but to arrange them at my convenience,—and this is a very simple and easy matter.

"To be explicit, I place horizontally on a table or other support one of the metallic plates,—for example, one of silver,—and over the first I fit a second of zinc; on the second I place one of the moistened disks, then another plate of silver, followed by another of zinc,—this succeeded by another moistened disk. I continue in this manner, coupling a plate of silver with one of zinc, and always in the same order,—that is, the silver always below and the zinc above, or *vice versa*, according as I have begun, and interposing a moistened disk between each of these couples, I continue to form, out of several of these stories, a column as high as it can be made without danger of falling over."

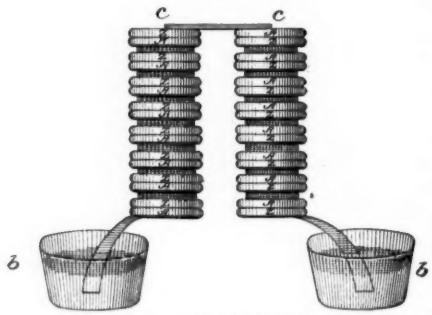


FIG. 1. VOLTA'S COLUMNS.

In the illustrations Figure 1 shows two such columns coupled together for greater effect, and constituting, either singly or together, what is commonly known as the voltaic pile. Volta's "crown of cups," typical somewhat more nearly of the modern battery, is shown in Figure 2, and described as follows in Volta's letter to Sir Joseph Banks.

"Take a row of several cups or basins of any material except the metals,—say, wood, shell, earth, or preferably glass (small drinking glasses or tumblers are the most suitable),—half full of pure water or, preferably, salt water or lye. Connect them all by forming them into

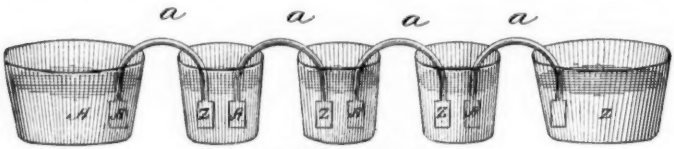


FIG. 2. VOLTA'S CROWN OF CUPS.

a sort of chain by means of so many metallic arches, one arm of which, Aa (or, at least, the extremity, A, which is immersed in one of the tumblers), is of copper or brass, or, preferably, of copper plated with silver, while the other arm, Z, which is immersed in the next tumbler, is of tin or, rather, of zinc. I will remark, in passing, that lye and other alkaline liquors are to be preferred when one of the immersed metals is tin; salt water, when it is zinc. The two metals of which each arch is composed are soldered together at some point above the part which is immersed in the liquid, and which part ought to touch the liquid with a pretty large surface of contact. It is sufficient for this purpose, if this part be a plate an inch square or a little less. The rest of the arch may be as much narrower as you choose, or even a simple metallic wire. It may also consist of a third metal, different from those immersed in the liquid of the tumblers; for the action on the electric fluid which results from all the contacts of several metals immediately succeeding each other,—the force with which this fluid is ultimately impelled is absolutely the same, or nearly so, as that which it would have received from the contact of the first metal with the last without any intermediate metals, as I have ascertained by direct experiments of which I shall have occasion to speak elsewhere.

"Now, a series of thirty, forty, or sixty of these tumblers joined in this way, and arranged either in a straight line or a curve, or bent in any manner, forms all there is of this new apparatus, which essentially and in substance is the same as the column described above. For the essential thing, which consists in the immediate communication of the different metals forming each couple, and the intermediate communication of one couple with another,—namely, by the interposition of a humid conductor,—is characteristic of one of these devices no less than of the other."

Such was the simple—not to say crude—apparatus with which Volta demonstrated that artificial electricity could be made to act continuously,—as a current,—and not merely explosively and intermittently. This device was the first generator of electricity in motion; it was the real beginning of the science of electro-dynamics. Volta himself gives a remarkably just account of the characteristics of his new invention, though the fundamental explanation of the action eludes him, and leads him to a construction of his column not only crude, but essentially false. He attributes the effects primarily to the mere contact of metals or other conductors of different kinds, and he does not seem to comprehend the true action of the moistened disks; yet he is in the main impressed by the real, and not the fictitious, wonders of his apparatus. Over the contact and the chemical theories of the battery—the galvanic battery, as it came to be called—a dispute of many years has been

waged, in which greater men than Volta have been involved. But the one who made the first voltaic cell had no doubt, it seems, that the generation was brought about by mere contact. He tells his correspondent that he takes pleasure in communicating to him—and through him to the Royal Society—some striking results which he has obtained in the pursuit of his experiments on electricity excited by the mere mutual contact of different kinds of metals, and also on electricity excited by the contact of other different conductors, whether liquid or containing some moisture. "The chief of these results," he writes, "which comprehends nearly all the rest, is the construction of an apparatus which, in its effects,—that is to say, in the shocks it is capable of causing in the arms, etc.,—resembles the Leyden phial, or, rather, a weakly-charged electric battery which acts continuously, or whose charge renews itself after each explosion. In a word, it is like a battery having an inexhaustible charge, a perpetual action or impulsion on the electric fluid. Nevertheless, it differs essentially from such a battery, by virtue of this characteristic continuous action, and because, instead of consisting, like ordinary electric phials and batteries, of one or more insulating plates or thin layers of those bodies which alone are thought to be *electric*, armored with conductors or bodies called *non-electric*, this new apparatus is formed solely of several of the latter bodies, selected from among the better conductors, and thus as remote as possible, according to what has always been believed, from the electric nature. Indeed, the apparatus of which I speak, and which will, no doubt, astonish you, is nothing but an assemblage of a number of good conductors of different kinds, arranged in a certain manner."

The "battery" of which Volta here speaks is, of course, a group of Leyden jars coupled together. That his "electro-motive apparatus"—for so Volta in one passage names it by a happy inspiration—is inferior to such batteries, when highly charged, in respect to the force and the noise of the explosions, in respect to the spark, and in respect to the distance at which the discharge may be effected, Volta freely admits. "It equals," he says, "only the effects of a very weakly-charged battery, though having immense capacity. But in other respects," he adds, "it infinitely surpasses the virtue and power of these same batteries, as it has no need, like them, of being charged in advance by electricity from another source, and as it is capable of giving a shock every time it is properly touched, no matter how often."

In this connection Volta enlarges upon the likeness of the "artificial electric organ" which he has invented to the "natural electric organ" of the torpedo or electric eel. By the former name, indeed, he prefers that his instrument should be called. For is it not, like the

natural electric organ, composed entirely of conducting bodies? Moreover, is it not active of itself, without any previous charge, without the aid of electricity excited by any of the means hitherto known? Does it not act incessantly and without intermission? And, finally, is it not capable of giving at any moment stronger or weaker shocks, according to circumstances,—shocks which are renewed by each new touch, and which, being thus frequently repeated or continued for a certain period, produce the same torpor in the limbs as is caused by the torpedo?

As to the general principles of action of the new source of electrical energy, such principles are, after all, deduced from experiment, and Volta's experiments taught some things in the rough which it became the province of the later science to develop with exactitude. For example, Volta could not help observing that the force of the current was increased by the multiplication of the "stories" of his column or the cups of his crown. And he also notes the mutually-neutralizing effect of groups of cells having the elements arranged in opposition to each other; so that Davy, when he obtained unheard-of results by the use of his battery of 400 five-inch plates, and his other battery of 40 plates 12 inches across, only made use of the greater effects which Volta, too, knew to reside in the larger battery. If we owe the discovery of potassium and sodium and magnesium and strontium to Davy, we can at least see how Volta set the first guide post.

The most remarkable feature of the new contrivance from a purely characteristic scientific point of view was the production of electricity through the medium of good electrical conductors. The substances originally called electric were amber, glass, silk, and the like. By rubbing them one could get an electric spark. Volta exhibits great surprise at finding that he can obtain electricity from good conductors or so-called non-electric bodies.

Is it true, then, that this small column and this crown of cups, which, by their inventor's own account, were weaker in their effects than a highly-charged battery of Leyden jars,—is it true that this apparatus affected the imagination of science, and aroused hopes of some new and strange development in the world of industry and the arts? Undoubtedly. For, while the dynamic effects were no greater than what had long been known, yet some of the effects were theretofore completely unknown as the product of an artificial apparatus. The molten, flowing element had more of promise and adaptability in it than the congealed electricity of the frictional machine and the Leyden jar. It is not too much to say that the world of science was never more thoroughly awakened than it was by the publication of Volta's letter. The main thing therein that was disclosed by Volta's experi-

ment was that electricity could be set and maintained in motion by an artificial appliance. It appears that Volta looked upon his generator as inexhaustible, subject to no waste, so far as he suggests. It remained for later investigators, like Ampère and Ohm, to fix mathematically the laws of flow of the mysterious voltaic current. That his powers were not adequate to this particular part of the work was frankly and characteristically acknowledged by Volta, who waited for others to do what he could not. And it was not till the year of Volta's death (1827) that Ohm, in his "Galvanic Circuit Treated Mathematically," finally stated the fundamental principle of electric flow in his famous law. But meanwhile improvements in the voltaic battery had been going on without ceasing, and they continued to do so, the chief names of honor being Becquerel, Davy, Smee, Wollaston, Daniell, Grove, Bunsen, and Léclanché.

In connection with the later enunciation of the laws of current flow and distribution, the following passage from Volta's letter is of more than ordinary interest. It follows the description of the crown of cups already quoted.

"It might occasion surprise that in this circuit the electric current, having a free passage through a continuous mass of water in the basin, should quit this good conductor to throw itself and pursue its course through the body of the person who holds his hands immersed in this same water, thus taking a longer course. But the surprise will cease, if one reflects that living and warm animal substances and, above all, their humors are, in general, better conductors than water. Since the body of the person whose hands are immersed in the water offers an easier passage to the electric torrent, the latter must prefer it, though it is a little longer. In a word, the electric fluid, when it has to traverse imperfect conductors in quantity, and particularly moist conductors, likes to spread in a larger stream, or to broaden into several, or even to make detours, as it thus finds less resistance than in following a single course, though shorter."

If Volta had not arrived at the conception that the current from his electric source divided between different conducting paths in the inverse ratio of their resistances, he was very close to it. Such a conception presupposes an understanding of Ohm's fundamental law, and yet it required twenty-seven years to evolve the clarified mathematical statement of it in the equation, $C=E/R$. Yet that, again, was a masterpiece of scientific deduction from which no fair-minded student of history would wish in any way to detract. Let Ohm enjoy the glory of having been one of the few to discover and to enunciate a true natural law; only let us not overlook the fact that Volta not merely gave us an epoch-making discovery, but hinted also at the

same permeating law whose later authoritative promulgation by Ohm has powerfully influenced the subsequent development of the theory and applications of current electricity.

As has been said, Ohm's chief work was published in 1827. As early as 1825, however, and later in 1826, Volta might have read the preliminary announcement of Ohm's main conclusions in the German scientific journals.

It would be instructive to analyze Ohm's treatment of the principles of electrical distribution, but, owing to the involved and far-leading character of his style, citation is next to impossible. I think science has about come to the conclusion that what it owes to Ohm is adequately summarized in the equation above cited, known as Ohm's law. Of course, other laws equally true and authoritative are deducible from that one, or follow from the same course of reasoning, and such laws are stated in Ohm's thesis. But the basis of Ohm's contribution to electrical science is, after all, the half dozen characters of a mathematical equation. For the rest, it is enough to state here that Ohm arrived at his conclusions through the analogy of heat conduction. It has been said of Ohm that he would never have done his work but for the antecedent investigations of Fourier on the subject of heat. But whereas, owing to the nature of the subjects of inquiry, Fourier's theory was carried only to the point of probability, Ohm's deductions reached the point of absolute proof, so that they have been fortified by every later investigation without exception. As we have seen, Volta himself was not without an incipient conception of the truth of the matter. Others, with the same phenomena before them, likewise hovered around the true notion, or talked loosely of the functions of the electric current, each with his own terminology. Antiquarians even declare that Cavendish, in 1781, made an equivalent mathematical statement of the law, preceded by a general discussion, in 1775, of the mode of electrical distribution between conductors of different resistances. It was a part of Ohm's service that he insisted upon separating and naming the different functions, and proceeding by the methods of science. That his term electroscopic force and others of his suggestion have passed into disuse is insignificant. They served the greater end of enforcing definition, no matter if the specific thing defined was afterwards thought to be better described by a different word or phrase. Having brought scientific men to book by making them say what they meant by "current" and "intensity" and "quantity" and so on, he then gave them the law which, before that, was impossible of statement.

MISTAKES AND IMPROVEMENTS IN RAILROAD CONSTRUCTION.

By George H. Paine.

II. PRESENT ACCEPTED STANDARDS IN PERMANENT WAY.

IN the introductory article on this subject, appearing in these pages a month ago, some account was given of the causes which have contributed to our present tendencies and best practice. The subject was attacked in a general and retrospective manner, without any attempt at drawing definite conclusions.

Here, however, the track and other matters will be treated in detail, and an effort will be made to show what is regarded as good track and in what direction the indicated improvements will probably take place.

In the construction of the embankments, which constitute the foundation, very little advance seems to be possible, since they are of the simplest form. To be sure, earthwork is so obstinate that, no matter how beautifully it may be patted and smoothed, if it be not sufficiently sloped at the time it is made, it will soon, with the never-failing assistance of frost and rain, assume its natural shape, covering the rails through the cuts and leaving the ends of the ties unsupported at the fills. Nevertheless it has continued to be the practice to draw up specifications for railroad work according to the sections shown in Figs. 1A and 1C although it has been clearly recognized that the earth will not retain that form for more than a few months.

Two years ago Mr. D. J Whittemore (*Trans. A. S. C. E.*, September, 1894) asked the American Society of Civil Engineers why such a method should prevail, and suggested that the banks and slopes be originally made to take the form which it is known that they will eventually assume, and offered the sections shown in Figs. 1B and 1D as a substitute. It is not a cause for wonder that substantially the only answer to his question was the Yankee one: "Why not?"

As a subordinate matter, Mr. Whittemore proposed that the slopes be sodded, and the ditches paved and sub-drained as soon as possible after construction, leaving time, of course, for the embankments to settle before covering them. This also seems well, and, although it would involve an expense not to be lightly assumed by a new or an unprosperous road, there is little doubt that there would be an ultimate saving in nearly every case.

Even a slight acquaintance with railroad engineering is enough to

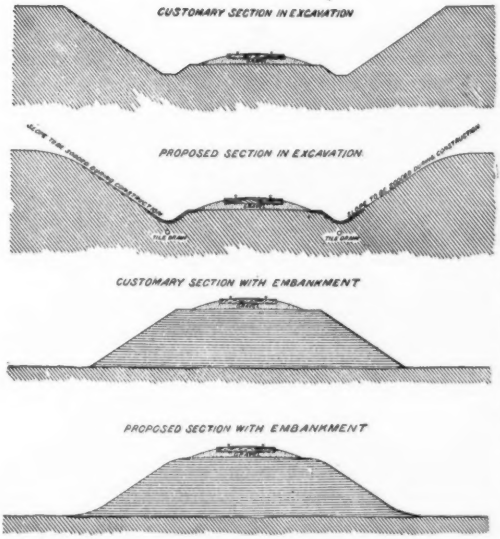

CUSTOMARY SECTION IN EXCAVATION
PROPOSED SECTION IN EXCAVATION
CUSTOMARY SECTION WITH EMBANKMENT
PROPOSED SECTION WITH EMBANKMENT

FIG. I. PRESENT AND PROPOSED SECTIONS FOR CUT AND FILL.

convince one that, from a maintenance standpoint, good drainage is the most important result to be secured. Its ramifications are wonderful, and the different conditions which are affected by good or bad drainage make it appear as the one thing which must be remembered, though all else be forgotten.

There are three problems to confront in draining a railway: first, how to dispose of the water which flows under the track in the form of streams; second, how to protect the embankments and slopes against the attacks of surface water; third, how to carry off the water suspended in the soil under the slopes in cuts and under the track itself.

It is evident that the first problem is to be solved only by bridging; it resolves itself immediately into a question of length. After the length of the bridge has been determined, its character is the next consideration, and this is usually decided upon a basis of first cost, expense of maintenance, and general suitability. In the first quarter-century of railroad building but two materials were generally available for bridges,—wood and stone,—although before this period many attempts at iron-bridge building had been made. There is not opportunity in this article to recount the different forms of metal bridges which have been tried; it is sufficient to say that mild steel is the almost universal material in present use. Timber bridges still linger in the form of Howe trusses and trestles in the newer and less settled portions of the country, but renewals are being made in steel, more and more as time goes on, as the cost of timber increases, and that of steel decreases.

Nothing will ever surpass the stone arch in stability or the appear-

ance of rugged strength; as it was the original permanent form of bridge, so it will remain, to engineers and laymen alike, the perfect embodiment of beauty and utility. But the stone arch has many limitations from an economic standpoint. Its first cost is immense as compared with that of metal bridges, and is not adaptable to very long spans (the Cabin John bridge at Washington, 220 feet long, is the greatest in the world) or to situations where it is difficult or impossible to erect "false work,"—that is, the staging on which the arch is formed and supported. The steel arch, however, is not open to these objections. Very long openings have been and will be spanned by it; witness the beautiful creation called the Washington Arch over the Harlem river in New York city, which has a span of 510 feet, and the one which is to supplant the Suspension bridge at Niagara Falls, with a span of 840 feet. It is a matter for regret that no attention seems to have been paid, in the design of this last bridge, to those elements of grace which make a sight of the Washington bridge an unalloyed pleasure.

One of the reasons which probably operated, until within a short time, to maintain the stone arch in the high regard of railroad engineers was the ease with which the track might be placed on it, since it is evident that the only thing to do is to carry the ballast and ties across in exactly the same way as track is laid on an ordinary embankment. As it happens, this is the best thing to do also, but it was impossible, or practically so, on the old wooden bridges, and it was not until the idea of the buckle-plate floor, Fig. 2, was conceived that this method of track-laying began to be followed on girder and truss bridges, where it has since been applied to many spans, some of them of considerable length. Sometimes cross-ties and ballast are used in the spaces marked A; at other times, as in the recently-completed Harlem railroad elevation, the rail is laid directly on the buckle-plates and fastened to them by bolts and clips. The reasons which incline one to think that the solid floor will continue to grow in favor are not far to seek: first, it is believed to distribute the weight of the moving load over a greater area than is possible with the usual floor-beam and stringer construction; second, it provides a safer path for a derailed car.

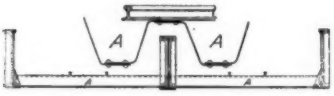


FIG. 2. BUCKLE-PLATE FLOOR.

Reverting again to the question of drainage, the statement is recalled that the second problem to be solved is how to best protect the slopes from the attacks of surface water. This has already been touched upon in the reference to Figs. 1B and 1D, and it is now necessary to say only, that turf is both the most convenient material and the best

that has ever been found for the purpose, while, in addition, its esthetic features must be recognized,—a consideration which, unhappily, is too seldom regarded in this country.

One of the greatest helps to the railroad engineer is the tile drain; it is not possible to exaggerate its usefulness, for wherever it is needed nothing in its place can be more than a makeshift. For the sub-drainage of wet slopes,—to carry off the water which sinks through the ballast and remains suspended under the track, where it will freeze and, as the saying is, "heave" the track in winter,—the tile drain is invaluable, and will be used increasingly as its advantages become better known. To go on month after month, year after year, shoveling slime from the track and ditches in a wet cut, when a less costly means of obviating it exists, seems rather ridiculous, if viewed in the light of pure reason; but it has been the common practice, and it is that, among other things, which the proper and free use of the tile drain will prevent.

Where good stone can be secured at a moderate cost,—say, one dollar per cubic yard,—it is in almost every particular the best material for ballasting the main track of a busy railroad. Perhaps the only reason, under such circumstances, for using gravel instead of stone would be the possibility of securing exceptionally fine gravel at a very small price. But exceptionally fine gravel is a rare thing,—so rare that, as a rule, the first statement may be taken as an established truth and no longer requiring a demonstration. In this place, however, it may be well to state a few of the reasons for the belief.

First: even passably good stone ballast provides better drainage than the best gravel; since this is the most important object to be secured by ballast, the force of the reason is evident. Second: by simply picking stone ballast out from between the ties and handling it with a fork or throwing it against a screen it may be cleaned and made as good as new; there is no generally feasible plan for cleaning gravel ballast. Third: greater rigidity of track follows the use of stone than is possible with gravel, and, since the whole effort is now to increase the immovability of the track, both vertically and horizontally, this is an important consideration. A last reason, and a good one from the passenger department's standpoint, is the avoidance of dust by the use of stone ballast.

At almost any time within the past ten years, it would not have been regarded as either heretical or startling if the statement had been made that the metal cross-tie had come to stay, and that the use of wood must decline; but it would not have been true, since the use of metal for this purpose has not apparently increased much, if any, although its advantages are well known. Some of the causes

for this failure of steel to make its way in a place where it is entirely appropriate (apparently much more so than wood) are very simple. The cost is four or five times that of a timber cross-tie, and there is a wide-spread belief that the greater elasticity of track supported by wood is desirable. The last reason was discussed in the previous article, and need not be further treated here.

The average life of an oak cross-tie is about eight years,—seldom more than ten,—and its destruction is due to various causes. Of these the principal one is ordinary decay, hastened by the alternate wetting and drying to which the tie is exposed; next in importance is the destruction of the fibres directly under the rail, which are exposed to the blows delivered by the train; lastly, in certain localities many ties are destroyed through frequent re-spiking, and the consequent multiplication of holes, which fill with water and add to the tendency to decay, as, for that matter, the second cause does also in a great degree. Much progress is now being made in the treatment of ties with different preserving compounds intended to destroy at their inception the fungi which are the direct cause of decay. It is not yet possible to say which of these preservatives are best, or whether any of them have reached that stage of perfection which will ensure a long continuance of the efficiency that undoubtedly exists during the first few years of their presence in a piece of wood. The difficulty seems to have been in the finding of a compound which shall at the same time be effective, low in price, and not soluble in water; the immense advance which modern chemistry is making encourages the expectation that the problem will be solved. If it is, the question of metal ties will be transported into a dim future, since, instead of having to renew all the ties in the main track of a railroad at least once in every eight years, the period may be extended to twenty years, or even more.

Any discussion of this subject would be incomplete without a description of the one device of all others which, taken in connection with some wood-preserving process, will enable our railroads to postpone indefinitely the use of metal ties. This article is the Servis tie-plate, a thing so simple in form and idea that the wonders which it works are incomprehensible unless the conditions are understood. It is a plate of steel whose long edges (A B, Fig. 3) are turned down in the shape of ribs and sharpened so as to permit them to enter the tie parallel with, and without destroying, the grain of the wood; incidentally other ribs may be placed between the outside ones, but they are not essential. These ribs act as girders, and prevent the plate from buckling or curling up at the ends under the downward pressure of the rail,—a fault which must exist in all plates not provided with them, unless these other plates are made so thick as to

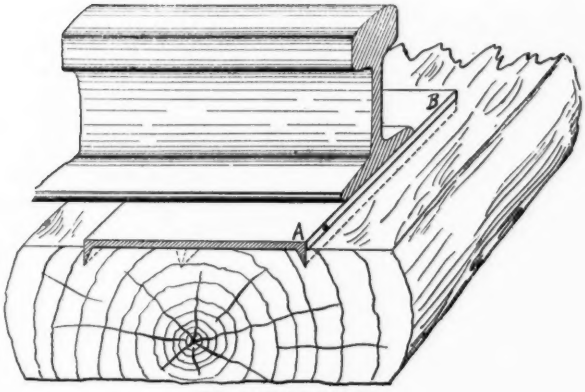


FIG. 3. THE TIE PLATE.

destroy their usefulness through a different cause. The ribs also act as a lateral support to the rail by assisting the spikes to perform their duty. Until this means of protecting the tie from the pounding and crushing by the rail had been discovered, only the harder woods, such as white oak, were available; but there are other kinds of timber that resist decay just as well as oak (some of them better), which are too soft, unless protected, and these are already coming into use under the fostering care of the tie-plate.

Thus it is seen that the two chief enemies of the wooden tie, decay and abrasion, are likely to be greatly weakened, while the supply of new material is immensely increased through the opportunity of using a greater variety.

When the double-headed rail, which is still the standard on most British lines, disappeared from this country, there went with it the chair which must always be used to fasten it to its support, and its place was taken by a device substantially the same as that which we are using to-day—the rail spike. If there is a spot in our track which is patently weaker than others, it is the spike, but there is nevertheless a good reason why it has been allowed to remain. Of all the horrors which stare a maintenance-of-way engineer in the face, "shimming" is the worst. It means, first of all, that the track is insufficiently drained, sometimes from lack of proper ballast, sometimes from inadequate ditches; but, whatever the cause, bad drainage in our latitudes always means heaving track and shims for four months in the year. Of course this is due to what is by courtesy called "economy," and for real ingenuity is on a parallel with the act of the man who cut off his dog's tail, made a soup from it, and gave the

dog the bone; whatever it may be called, the lack of drainage is the direct cause of shims, and shims apparently are the reason for the spike in its present and historic form. On heaving track the rail fastenings must be removed once in the winter and once in the spring, in order that the rail may be either raised or lowered to meet the changing elevations caused by the frost swollen earth, and the most convenient fastening for the purpose is the rail-spike.

The objection to the common spike in its present form, as already demonstrated, is not confined to the direct harm which it does; its inefficiency is proved by the fact that it has to be re-driven. The tie plate gives it a much-needed bracing laterally, but nothing apparently can be done which will add much to its vertical resistance. Notching it, curving it, changing its angle with reference to the rail, and many other alterations have been tried, but none of them have increased its holding-power to the degree which must be secured in order to bring this detail of the track up to the standard of modern requirements. How this will be finally accomplished is of comparatively little moment here, but it is appropriate to say that it will probably be in the direction of a lag screw, possibly somewhat after the fashion suggested by Col. Katte, chief engineer of the New York Central & Hudson River Railroad, wherein a limited lateral movement for the adjustment of the rail is provided by means of clips (Fig. 4); these can be slightly moved with reference to their distance from the base of the rail by tightening or loosening the lag-screws as it may be desired to shift the rail in one direction or the other.

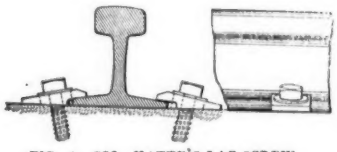


FIG. 4. COL. KATTE'S LAG SCREW.

Probably the most uncertain tendencies in the permanent way of a railroad are connected with the question of rail joints. There are plenty of radical defects in the angle bar, whether it be the four-hole or six-hole bar, and there are few engineers who are not convinced that some particular one of the many patented devices is better; but, on the other hand, few of these engineers seem to agree as to which of the improvements is best, so that to indicate a general preference for any individual form is impossible. If there is a tendency, it seems to lie in the direction of a bridge joint, either as a girder (Fig. 5), or as a truss (Fig. 6), and in nearly every case toward an arrangement which carries the weight of the train directly to the base of the rail (instead of largely under the head, as with the angle bar) and utilizes two ties as a support—in other words, as abutments—for the bridge joint. The

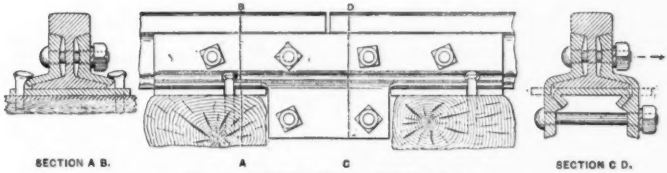


FIG. 5. BRIDGE JOINT, GIRDER FORM.

two forms illustrated, it will be seen, provide for the lateral continuity of the rail by means of fish plates (some are in the form of angle plates, some are plain straps), and this is typical of all modern patterns.

Recent experiments seem to show that the expansive force of steel, and the inclination to buckle, if confined at the ends, during an increasing temperature, have been greatly overrated; and, if this be so, another method is likely to step in and settle the question permanently by entirely eliminating the joints. Until within a short time it has been the universal practice, and is still almost so, to lay the rails with slight spaces between their adjoining ends to permit automatic local adjustments under varying temperatures, but on some electric lines the plan of "butting" the ends has been tried with extremely good results. Mr. Torrey, chief engineer of the Michigan Central Railroad, has also tried some interesting experiments with long stretches of rigidly-connected rails, which show, as before stated, that the behavior of rails under considerable changes from heat to cold and *vice versa* is different from what might have been expected. Previous to Mr. Torrey's investigations, the idea had been patented and tried, but in an unscientific manner, while he kept bi-daily records of the temperature of the atmosphere, of the rails, and of their movements.

Three distinct methods have been practised for accomplishing the union between the ends of rails. The first, which consists in riveting the angle-bars together and to the rails, must be little better than a temporary arrangement, and scarcely superior to bolting them very tightly, since the connection can never be so intimate and permanent as where the metal is actually continuous. The second method is to cast the

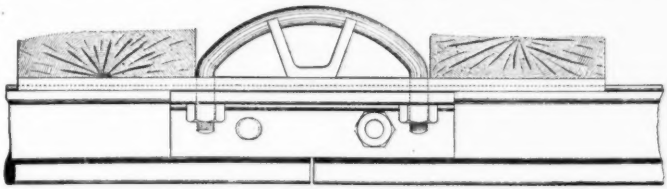


FIG. 6. BRIDGE-JOINT, TRUSS FORM.

ends of the rails together by means of movable molds, which are placed around the joint and poured from a portable furnace; the results of this practice are said to be good, and it is stated that the temperature of the casting metal is high enough to soften the skin of the rail, and in that way form a nearly, if not quite, perfect union. The third plan bears with it an assurance of reliability which is not shared by the others; here, by means of an electric current, the ends of the rails are welded together, so as to form a continuous and nearly homogeneous line of metal.

But, whichever plan shall prevail, whether it be in the way of new joint appliances, riveting, casting, or welding the rails together, there is little doubt that the future individual rails will be longer than those of the present day; rails forty-five feet and sixty feet long are already common in the track, while almost all of the important mills roll in lengths of ninety feet, cutting them up into lengths of thirty feet before shipment.

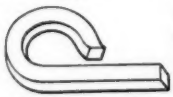


FIG. 7. NUT LOCK.

One of the track details which has always aroused great interest is the matter of nut locks: the patent-office records show hundreds of attempts and devices for preventing the nuts on track bolts from unscrewing. It may fairly be stated that none of these has been in any way successful, either commercially or in practice, which has not in one way or another resembled the Verona nut lock (Fig. 7). This small, but efficient, device acts in three ways,—as an ordinary washer, as a spring forcing the threads of the nut and bolt together, and as a grip, since the ends are bent and form cutting edges which dig into the angle bar and nut, interfering with the tendency of the latter to revolve.

The double-headed rail was abandoned early in this country, and, after coquetting slightly with other forms, we settled down upon the T rail, which seems to be the shape that will ultimately prevail. It has taken some curious forms, and, although it is believed that the present section is based upon a correct interpretation of experience, that same experience most assuredly says that there may be something better coming.

The only remaining feature of the rail pattern in general use ten years ago is its separation into three general divisions,—the head, the web, and the base, which constitute the T pattern; even the chemical composition has been changed, for the carbon has crept up from less than .40 to more than .60, while there are many who advocate a still further advance to .75.

A comparison of two patterns will be instructive. The dotted lines in Fig. 8 shows what was regarded by many as an extremely good section in 1886, and for several years after, where it was used. The

full line in Fig. 8, shows the section of a rail that was first laid in 1888, and typifies what is now considered the best form; this, with the exception of one or two unimportant details, has been recommended by a committee of the American Society of Civil Engineers.

It will be seen that the two most noticeable changes are in the dimensions of the head and the total height, while lesser alterations involve the amount of metal in the base and web. The chief faults in the old section were the internal strains caused by the unequal cooling of the different parts after leaving the rolls; the lack of surface on the top of the head, which allowed the metal to be actually squeezed off by the wheels of a locomotive or car; and, finally, the inadequate vertical stiffness of the rail as a whole. By the change in form shown in the figure (for there is the same quantity of metal, yard for yard, in both sections) these troubles have been largely corrected; since the rail has been in service for many years and continues to fulfil the hopes expressed for it originally, it may safely be considered that one which will be most highly regarded for many years to come, should the present form of track be continued.

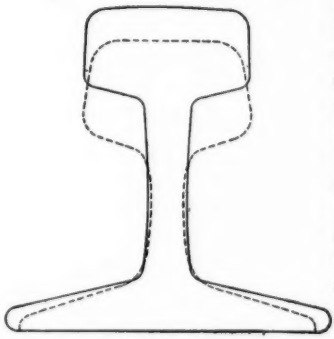


FIG. 8. RAIL SECTIONS.

It has appeared to many railroad engineers of importance, as well as to others of lesser reputation, that a continuously-supported track —that is, without the lateral "sleepers" commonly called "crossties"—would offer many advantages over the present manner of construction, which, since the rail is supported only at intervals, is necessarily uneven. Several plans have been proposed, differing so much in detail that it is impossible to describe them here; one method, however, combines so many attractive features that it cannot be ignored. It is the outcome of long-continued experiments by two Germans, Mr. Haarmann and Dr. Vietor, who exhibited it at the World's Fair in 1893 (Fig 9.). The rail has a width of base and a height of about 8 inches, as against a width of base and height of 5 inches in the rail illustrated in Fig. 8: by means of the peculiar section, it is possible to cut off the head and base on the line A–B for about 10 inches back from the ends of the rail without destroying the web; then, by overlapping the ends and bolting them together with six-hole angle bars, a joint is made, which is substantially as strong vertically as the rest of

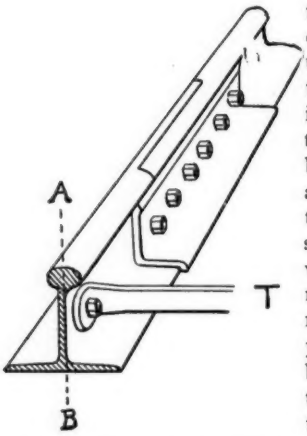


FIG. 9. HAARMAN-VIETOR RAIL.

the rail. The rails on opposite sides of the track are tied together at intervals by the bars, T, to maintain the gage. This rail is laid directly in the ballast without the interposition of sleepers, a thing made possible by the great width of the base; and from long use it has been proved to furnish not only a remarkably smooth track, but one which is also very cheap in repairs. A similar method, it is said, cost for maintenance but twenty dollars per mile per year for a period of ten years on a busy main line. In cost of construction this plan considerably exceeds that of the prevailing one, but, in view of the economies claimed for it, the original expense seems to be of small importance, and it is, therefore, surprising that some move has not been made toward testing it on at least one of our long-established railroads.

In the matter of switches and frogs nothing radical need be expected. The split switch is a beautifully simple and effective device, and, the simpler it is, the more effective. It has an honorable record,

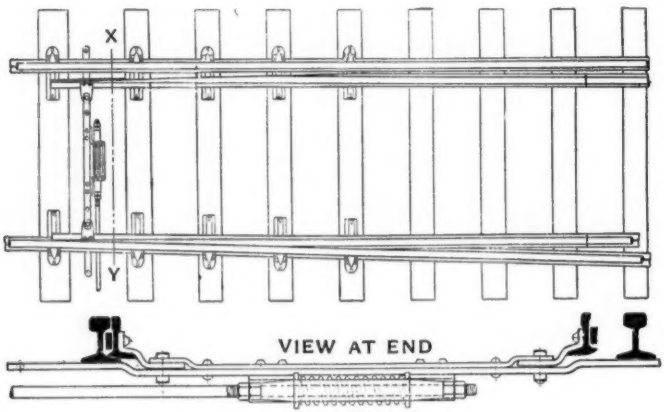


FIG. 10. A SPLIT SWITCH.

and, of the different forms, the one which seems worthiest of description is that which consists of the fewest pieces. In Fig. 10 a form is shown which does not contain a nut to unscrew or a weld to break, while, if an adjustment is desired, it can be provided in the rod, which joins the switch to the switch-stand. It differs radically from the ordinary form in one feature; it has only one rod, whereas the usual switches have four or five. Why they should have five rods it is impossible to guess, unless it be for the same reason that we find ourselves provided with a vermiform appendix; time was when they all served a purpose, but, now that their usefulness has passed, they stay simply because they will not drop off of themselves, and no one else seems inclined to interfere with them. The old stub switch needed five rods to hold the sliding rails together, but the split switch rails, being braced on the outside, require no such assistance.

Without doubt, opinion is now fixed in a manner favorable to the spring-rail frog, which, however, differs from the split switch in that it moves automatically within itself, and therefore can never be so

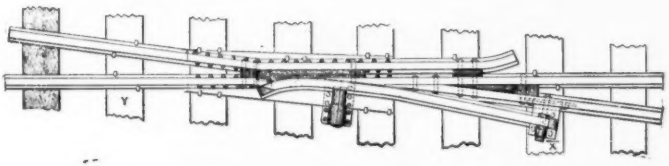


FIG. 11. A SPRING-RAIL FROG.

simple in construction as the switch. Experience, nevertheless, has developed its weak points, which have been fully corrected, and it may be now taken as the standard for high-speed main-track work. It is built in so many different ways that any but a very general description is impossible. Briefly, its purpose is to provide a continuous rail for wheels passing over the fast track. The particular form illustrated in Fig. 11 is modern in design, and represents much that is desirable, but not contained in the ordinary spring rail frog. Its main claim to attention lies in the hinging of the spring rail at X, instead of having the rail from X to Y free to move, as in the most common form.

A recapitulation of the tendencies in maintenance-of-way work resolves itself into two clear propositions.

First, a better understanding and appreciation of the immense importance of the drainage question, which implies a freer use of subsoil tile drains and much more attention paid to the quality and quantity of the ballast used.

Second, increased efforts to secure an immovable track.

MODERN LOGGING IN THE NORTHWESTERN STATES.

By Edward K. Bishop.

LIKE many kinds of business, the logging industry encounters varying conditions in different sections of the country, and must adapt itself to the requirements of the locality in which it is carried on. Even the seasons of activity are by no means identical in different sections of the country, as, in the pineries of Michigan and Wisconsin, the snow of winter is generally considered a necessary factor in logging operations, while, in the forest camps of Oregon and Washington, the bulk of the labor is done during the summer, and the approach of winter is the signal for the close of the year's work, when the men repair to the town.

The cause of the great difference in the manner of logging is to be found in the climatic conditions, the topography of the country, and the peculiarities of the timber to be handled. Manifestly, a method eminently suited to the cypress swamps of the south would be out of place in some mountainous locality of the Pacific northwest, and one well adapted to handle the small eastern timber would be useless among the giant redwoods of California.

A description of the latest and most improved system of logging, as carried on in Oregon and Washington, may be of interest to the general reader who enjoys a glimpse into the workings of an unfamiliar industry, as well as to the lumberman and those connected with some branch of this vast lumbering business, which, in point of capital invested and number of men employed, is the greatest manufacturing industry in our country.

Until recent years, logging in this section was carried on in a rather primitive way, the entire work being done by hand, with the help of oxen. The competition of an increasing number, as well as the necessity of going farther away from the large waterways for timber, brought about the use of steam in logging operations, and led to the adoption of many devices for reducing the cost of transportation and handling to the lowest possible figure. The use of chutes, railroads, and donkey engines was the logical outcome of these conditions, and, in recent years, there has been added what is known as the bull donkey,—a machine previously used somewhat in California, but also adapted to this section. A logger of the old school would be amazed at the ease with which one of these equipments will perform

in a day what would have required weeks of work from his team of oxen.

It should be noted that, in handling the timber of these States, the most important considerations are its large size, the rough nature of the country, and the necessity of doing the work in summer.

While far below the redwood in size, the fir and spruce of this section grow to very large dimensions. The mill man considers nothing a log that is not at least sixteen feet long and sixteen inches in diameter at the small end, and the average log will cut from 1,000 feet to 1,500 feet of lumber, according to the locality. A spruce log that cut over 15,000 feet is on record, and frequently the specifications for foreign shipments call for fir timbers 24 × 24 and 100 feet long.

The topography of the country differs greatly from that of the eastern timber States. The Cascade and Coast Mountains extend through the entire section, making what the Michigan timber cruiser would consider a very rough country. Hill and valley succeed each other so continuously that there is no level land, with the exception of that found on benches, or small plateaus at varying elevations.

The rainy season, which sets in about November and lasts throughout the winter, makes work in the woods very trying for man and beast, and restricts most of the activity to the fine weather of summer. In some low sections the timber is felled in summer, and lies in the woods till it can be brought out by the help of the spring freshet on some small stream; but this is an uncertain and unpopular method of logging.

The first step in all operations in the woods is to fell the timber,—an operation which is unlikely to undergo modification. The timber fellers work in pairs. After selecting a suitable tree, they each cut a notch in its side, into which a spring board about four feet long is inserted. Standing on this, they cut a second notch higher up, and perhaps a third, thus reaching the point at which it is desired to cut the tree. This is done in order to avoid the bulge and accumulated pitch of the butt. Standing on this apparently insecure perch, they use the axe and long double-handled saw, the latter being most in evidence. They become very expert, and drop a tree between two stumps, or at any desired point, in a way that amazes the novice. When leaning heavily in one direction, a tree can be made to fall in exactly the opposite by the use of wedges.

Close upon the fellers come the cross-cut sawyers, who cut the trunk into logs of convenient length, and the barkers, who, with axe or spud,—an iron bar with flattened end,—clean the log down to the white wood.

The next step is to gather the logs from their isolated positions to

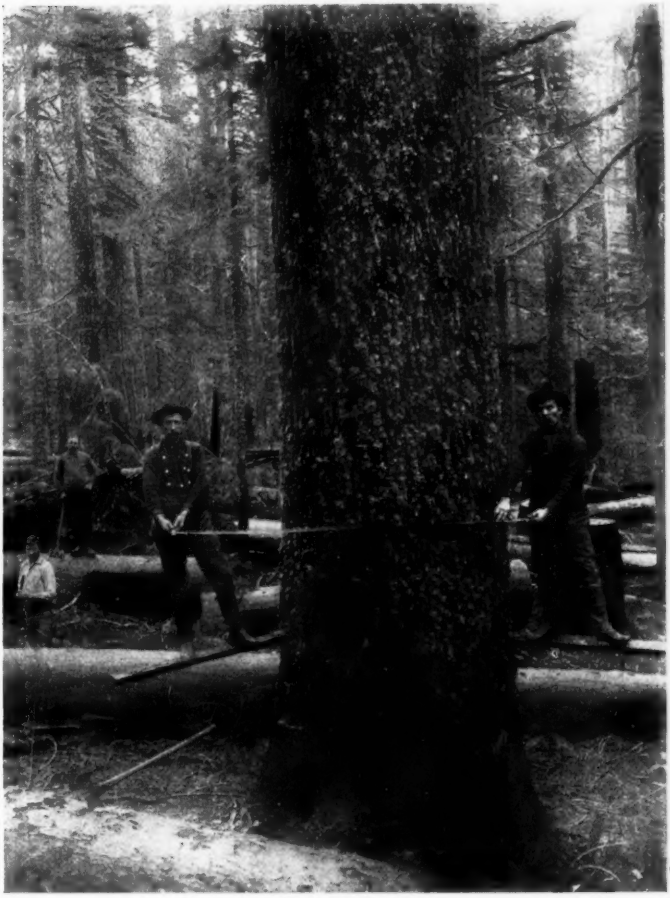
a central point,—yarding them out, the process is called,—and this, in times past, was always performed by oxen, which extricated them from even the most difficult positions with great skill. In the modern camp there is a donkey engine of from 25 to 50 h. p. for this purpose. A cable is run from the donkey to the log to be pulled out, and a dog, or iron hook, in the end is driven deep into the wood. At a signal from the hook tender, the log is pulled through all obstructions to the puffing engine. By means of blocks a pull in almost any direction can be made. The donkey is mounted on a sled, and can easily be changed in position by attaching the cable, which is from 200 to 500 feet long, to some secure stump, whereupon it will pull itself over the ground.

In many places, after being yarded out, the logs are formed into trains by being hitched end to end, and taken away by a long team of oxen under the direction of the "bull puncher," who, during the operation, makes free use of a picturesque vocabulary.

Wherever logs are hauled through the woods, skid roads are found, the road-beds so substantial in construction that they stand an immense amount of travel and, long after the departure of the logger, form a monument to his industry. Though much can be said in favor of their permanence and usefulness, they can hardly be considered good roads for pleasure-vehicles, as, at every five or six feet, a skid or log, ranging from a foot in diameter upward, according to location, stretches over the surface. The train of logs slides on the well-greased face of these skids with the least possible friction. The skid roads ramify through the woods in all directions, up hill and down, curving around or cutting through obstructions, often crossing little streams on log bridges as strong as they are rough. The skill of the civil engineer is required in those who lay out these roads, as a false direction, a too sharp curve, or an abrupt descent means trouble and additional expense.

When the timber near the mills and waterways began to be exhausted, and operations were carried on at a greater distance, necessitating a long and expensive haul by cattle on a skid road, logging railroads began to be introduced. These are found of both narrow and broad gage, and, with engines built for power rather than speed, they can handle an immense number of logs. The logs are loaded usually on very heavy trucks, the engine, by means of a cable, furnishing the power to roll them into position. The latest addition to logging appliances has been what is known as a bull donkey, which furnishes tremendous power for transporting logs, and combines with it the desirable feature of working a considerable area of country.

Equipments vary in detail in different localities, but a description



FELLING WITH THE SAW.

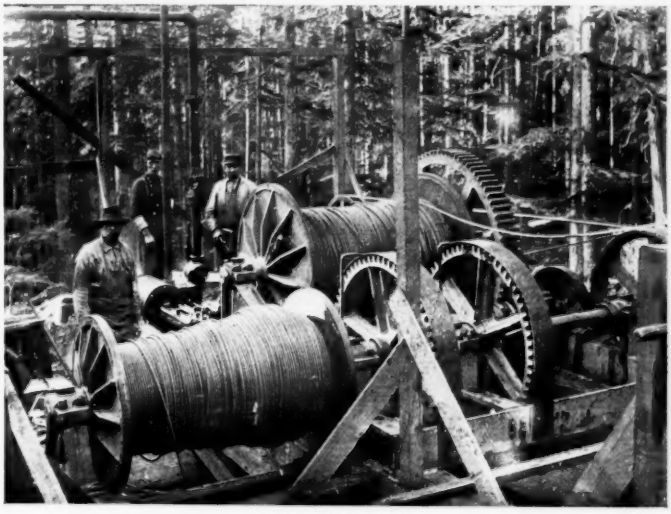
of one, located on the side of Larch mountain in Oregon near the far-famed Columbia river, will give an excellent idea of the typical logging camp of Oregon and Washington, with all the modern and progressive methods in operation, and will also bring out some unique features that are found in no other logging-plant in the country.

After being cut and yarded in the usual way, the logs are transported successively by a bull-donkey, a chute, and a railroad. The

YARDING LOGS WITH THE DONKEY.

TRANSPORTING WITH OX-TEAMS.

first is located farthest out in the woods, and is an immensely powerful machine, with two drums loaded with cable. Some idea of its size may be gained by considering that the larger drum, which is 30 inches in diameter and 5 feet between flanges, with its gear wheel, weighs five tons. A battery of two boilers supplies steam to the cylinders, one on each side, 10 inches by 16 inches in size. From the smaller drum, a light cable extends along a skid road to some point within a mile and a half of the donkey, where it passes over an idler and, returning to the large drum, is fastened to its cable, three-fourths of an inch in diameter, thus forming the means of drawing the latter out into the woods. Here it is attached to a train of logs, and, on being



THE BULL DONKEY.

rewound on the spool of the donkey, easily pulls its heavy load over the skids to the engine. The power is so applied that 30,000 feet of logs can be moved at one time, a load weighing about 120,000 pounds. Up to this point, the power is applied in the same manner as with the small yarding donkey, the only difference being the increased load and distance; but here the method becomes novel.

From the power house runs a chute for three quarters of a mile, the greater part on a six per cent. grade and with a steep descent at the lower end. Chutes, for bringing logs down from a hill, are of frequent occurrence, and are formed usually of three continuous logs, making a kind of trough, one at the bottom and the other two elevated

THE LOG CHUTE, LOOKING FROM THE BULL DONKEY.

to form the sides. These are sufficiently steep for gravity to furnish the motive power. The chute in question, however, is very different, as the logs will not move of themselves for the greater part of the way. So far as the builders know, there is nothing just like it in the country. Elevated for the entire distance above the ground, it is supported on a trestle much like that used in railroad-building. There are no ties on the stringers, the latter being planked over to form a continuous surface for the logs to slide upon, with a light guard-rail on either side to prevent them from rolling off. An endless cable extends from the

donkey to the crest of the hill, half moving on the surface of the chute, the returning portion being below. At the donkey it makes four turns around two grooved wheels, one attached to the main shaft and the second a snub wheel. This is done in order to apply the power to the cable without slipping. A reproduction, on a small scale, is thus made of the great cable-car systems of San Francisco and Chicago. Instead of pulling cars through the crowded streets of a metropolis, this cable transports trains of logs through the solitary depths of the forest. Unlike most places where a cable is used, the hold is taken at the rear end of the last log, which pushes the others ahead of it. When the logs run faster than the cable, the grip automatically loosens, only to take a fresh hold on overtaking the train. Thus they move onward, till the top of the hill is reached. The chute terminates in a large pond, formed by damming the cañon at this point. As the logs come upon the steep decline, they start forward, gaining headway as they advance, till a terrific speed is attained before they reach the pond, where they bury themselves in the water and throw a cloud of spray to a great height. The drop in 1,200 feet is about 300 feet. As the water at the end of the chute is too shallow to prevent the logs from being injured by digging into the sand and rocks beneath, the accomplishment of such prevention was a problem. A gradual upward curve in the end of the chute keeps the logs from sinking too far, but

THE FOOT OF THE CHUTE.

LOG RAILROAD, CHUTE, AND POND.

it was difficult to make a termination that would resist the tremendous pressure. Heavy timbers were moved and broken like straws. The solution arrived at was the placing of a heavy log to receive the impact. This is more than a hundred feet long, embedded in the bottom of the pond under water, with the upper face hewed slightly concave to receive the descending log, and so fastened with cross beams, railroad iron, and rocks that it seems as if an earthquake would fail to move it.

The bull donkey and cable system form a most satisfactory and economical means of handling logs. As can be readily seen, the direction of the cable extending from the power-house can be easily changed to reach any point in a radius of a mile and a half. A small donkey is used to draw logs within reach of the cable. It is estimated that over fifty million feet of logs are directly obtainable in the territory tributary to this chute.

The method employed in carrying the logs onward from the point which they have now reached is by a railroad several miles in length. It follows closely the course of a little mountain stream boiling down the cañon, crossing it many times on bridges, and with a plentiful supply of curves, one of them an exact horse shoe in shape. In construction it closely resembles that of any mountain railroad. The grade is so steep, being 6 per cent. on the average and with one short

stretch of 12 per cent., that means had to be devised to prevent the locomotive from running away with a loaded train. The means consists in covering the ties between the rails with boards running lengthwise, and on this surface, rendered slippery by the application of grease and water, having the engine pull a train of logs, hitched end to end, exactly as is done by the oxen on the skid road. It is the only place in the country where logs are pulled by a locomotive in this manner, and, at first thought, it seems that the high rate of speed and numerous curves would cause dire mishaps; but several years of successful operation have proved that the slight elevation of the rails forms a sufficient guard to keep the logs in the track. A train under way appears exactly like a huge snake winding down the cañon. From five to ten thousand feet of logs constitute a load, and an average speed of fifteen miles an hour can be maintained by the eighteen-ton locomotive. This logging equipment belongs the Bridal Veil Lumbering Company, and supplies logs to their mills.

In the majority of cases in Oregon and Washington, logs are put into some tributary of one of the large waterways, like the Columbia river or Puget sound, and are towed in rafts to the mill where they are to be converted into lumber. The vast belt of timber tapped by the above-mentioned logging plant could never have been brought to market in that way, as the rugged mountains skirting the Columbia

LOCOMOTIVE UNDER WAY WITH A TRAIN OF LOGS.

prevented the getting of logs to the water. Years ago, representatives of large mill companies examined the timber, and, though the quality was pronounced excellent, declared that it was practically valueless, on account of its inaccessibility. It remained for later comers to demonstrate that new conditions can always be successfully met by new methods.

Their plan was to place the saw-mill back in the mountains, where logs could be brought to it, and carry the lumber from the mill to a point where it could be shipped by a flume. Wise heads of the lumber business declared that timbers would never stay in a flume that had to be built with a fall of eight hundred feet to the mile,

TAKING A LOAD OF LOGS FROM THE POND.

but trial disproved this, and lumber of all dimensions, up to 16″ × 16″ and 60 feet long, has been successfully handled. The flume is V-shaped, and carries a stream of water, diverted from the creek, which serves to keep the lumber from being marred by contact with the sides, and also forms a medium that prevents the speed of the descending timbers from being accelerated beyond a certain point. Lumber is thus successfully carried a mile and a half in this flume in four minutes.

At present, there are few mills so located that their product must be brought out in this way, but there are many places where such a

method of transportation is the only feasible one. As timber becomes more valuable with the passage of time, the sound of the logger's axe will be heard in many a belt of fine growth now considered very remote.

Logging is being followed in a less haphazard manner than in previous years, and the study of earnest and thoughtful men is reducing it to a more exact science than it was in the days when the construction of the transcontinental railroads, and the consequent rush of settlers, caused such a demand for lumber that almost anything sawed out of a log could pass by that name.

The recent years of depression in the lumber industry, of course, reacted directly on the loggers, and demonstrated anew "the survival of the fittest," but the final result will doubtless be beneficial in causing closer attention than ever to be paid to ways and means, and in evolving the best possible methods of handling that most valuable gift of nature, the timber of her forests.

THE CURE FOR CORROSION AND SCALE FROM BOILER WATERS.

By Albert A. Cary.

II.

HAVING considered the troubles resulting from the use of certain boiler waters containing corrosive agents, we now may turn our attention to the impurities causing the formation of scale or incrustations.

Scale-making matter may be held in water in two different ways; in mechanical suspension, as small floating particles, or in chemical solution. The earthy or organic matter in suspension may be removed by settling or by filtration; but dissolved impurity requires treatment either by chemicals or by heat, the result being that precipitation takes place, whereupon we have the condition first named,—matter in mechanical suspension which must be cared for in some efficient manner before our treatment can be considered successful or complete.

When "muddy" water is used for boilers, too much care cannot be exercised to remove the earthy impurities. These frequently consist of clay, which, when mixed with the average precipitated matter in boilers, forms a hard, resisting scale, not unlike Portland cement. Finely-divided vegetable matter, which occurs suspended in the water of running streams, is sometimes beneficial when introduced into boilers along with untreated water; it often prevents the formation of a hard scale. Nevertheless, it is not always safe to allow these minute, solid organic particles to remain, for Lefévre proved conclusively that a rapid pustular corrosion sometimes found in boilers using such water is due to the oxidation of these particles, developing pectic acid.

One of the most important groups of salts described in our chemistries is the carbonates. They are most widely distributed, being found in considerable quantities in nearly every section of the globe. Thus carbonate of lime is found as limestone, marble, chalk, mollusk shells, and coral deposits. Carbonate of magnesium occurs frequently as magnesite, and, in combination with carbonate of lime, as dolomite, forming huge mountain masses.

Carbonate of iron exists in nature as siderite, or spathic iron. The "clay ironstone" is abundant in coal measures. Spathic iron also occurs in considerable quantities in gneiss and mica schist.

All of the carbonates are formed by the union of carbonic acid (CO_2) with some one of the metallic oxids, such as calcium oxid (Ca O), magnesium oxid (Mg O), iron oxid (Fe O), etc. The me-

tallic oxids just named, in combination with carbonic acid, form respectively carbonate of calcium, or, as it is frequently termed, carbonate of lime ($Ca\,CO_3$); carbonate of magnesium ($Mg\,CO_3$); and carbonate of iron ($Fe\,CO_3$).

Generally speaking, of all the scale-formers precipitated from boiler waters, none occurs so frequently or in so large proportions as carbonate of calcium; second to this comes carbonate of magnesium; while carbonate of iron occurs much less frequently than either of these, and never in large proportion.

These carbonates are but slightly soluble in water. For instance, carbonate of calcium seldom exists in water in greater quantity than one grain per United States gallon, although, under conditions occasionally found, a gallon may dissolve somewhat more than two grains. Carbonate of calcium is more soluble in cold water than in hot, and the presence of salt (chlorid of sodium) dissolved in the water increases its solubility somewhat. The same statement practically applies to carbonate of magnesium, but, when both are present, the total held in solution never exceeds the maximum quantity of either which an equal volume of water is capable of dissolving. Carbonate of iron is practically insoluble in water.

How is it, then, that these carbonates are found in large quantities in chemical solution in boiler waters? The explanation is to be found in the fact that gases are very soluble in water and, when present, aid it in dissolving the salts in question. Wanklyn states, in his "Water Analysis," that "in many natural waters there is more carbonic acid, in one shape or another, than any other single foreign material." This acid alone, under ordinary pressures and temperatures, exists in the form of a gas. It is very widely distributed in nature, forming a constant and essential constituent of the atmosphere, and is also contained in the soil, being one of the chief products of organic decay. Some is absorbed by the falling rain, and a very much larger quantity is dissolved as the rain-water passes through the soil. The wide and enormous distribution of the various carbonates, such as limestone, dolomite, and spathic iron, has already been noted. Now, although the carbonates are practically insoluble in pure water, they are very soluble in water containing carbonic acid. The solution does not take place, however, until some of the carbonic acid has been appropriated by the carbonate (a quantity equal to that already existing there), thus forming what is termed a bi-carbonate (or double carbonate). Thus carbonate of calcium becomes bicarbonate of calcium, which may be held in solution in the ratio of 51 grains to the gallon. Bicarbonate of magnesium is even more soluble, 362 grains per gallon being a possible solution.

Although 91 grains of bicarbonate of iron per gallon may be dissolved, natural waters generally contain but little of it.

The rain, then, generally reaching the earth charged with carbonic acid, and picking up and dissolving still more carbonic acid as it afterward passes through the soil, seldom escapes contact with some of the carbonate rocks, which dissolve in it as a lump of sugar dissolves in tea. Immense quantities of rock have thus been gradually dissolved; indeed, it was in this way that the Mammoth Cave in Kentucky and the Luray Caverns in Virginia were formed.

After passing over these rocks and forming new solutions, these waters reach the surface again, forming the constant supply of our rivers, lakes, and wells, from which we get our boiler feed-waters. The bicarbonates are very unstable, and are known to exist in water only in the solutions just described. They are very much more soluble in cold water than in hot, because a rise in temperature drives off the excess of carbonic acid and leaves behind the insoluble monocarbonates (or single carbonates). When a temperature of 180° F. is reached, a large percentage of the bicarbonates is precipitated as insoluble monocarbonates, and at 290° (the temperature of steam under 43 pounds, gage pressure) the precipitation is complete. This readily accounts for the large deposits in boilers where these salts are present in the water. As will be seen later, various apparatus have been constructed in which the feed-water is heated before passing to the boiler, and thus made to deposit most of its carbonates in the apparatus instead of precipitating them in the boiler.

The chemical treatment of these carbonates requires separate consideration. Let us take first bicarbonate of calcium. The removal of the salts of lime, magnesium, and iron is sometimes called the softening of water. The art of softening water for washing appears to have been known since the remotest period of antiquity, but not until 1841 was it successfully practised on a large scale. In that year the late Dr. Thomas Clark, of Aberdeen, Scotland, took out a patent for his well-known and beautiful process of softening water, and this has been the basis on which most of the more recent processes have depended.

The Clark process depends upon a very simple chemical reaction. One pound of carbonate of calcium is composed of nine ounces of lime and seven ounces of carbonic acid. By burning this one pound (in the form of chalk, marble, or limestone) in a lime-kiln, the seven ounces of carbonic acid may be expelled, leaving behind the nine ounces of lime, which is known as building lime, or quicklime. Although carbonate of calcium is scarcely soluble in water, the new product (nine ounces of lime) may be completely dissolved in forty gallons of pure water.

Now, taking another pound of carbonate of lime, we may make this soluble in water in another way by adding to it a second seven ounces of carbonic acid.

In order to precipitate the bicarbonate thus formed, by the Clark process, we have but to add to this solution the nine ounces of lime which we obtained from the lime-kiln, and the free lime will combine with the second portion of carbonic acid in the bicarbonate of lime, giving two pounds of the simple monocarbonate of lime, which, being insoluble in water, is precipitated at once in a floury form, leaving, when settled, a practically clear water. True, it will still contain monocarbonate of lime in the ratio of a little more than two grains to the gallon, but this small quantity is not noticeable in a boiler water.

When treating water by this process, care must be exercised not to introduce too much lime, as this will produce bad results; on the other hand, enough lime must be used to act on the entire bicarbonate. When using quicklime for softening, it should first be slacked, by pouring water upon it until it ceases to disappear by union with the quicklime. This forms hydrate of lime, and a further addition of about three times this quantity will form lime water, which is most desirable for this purpose. Dr. Clark recommended, to determine the results obtained in the treated water, a test with nitrate of silver. A more delicate test consists in using a solution of cochineal, whose natural yellowish red color turns violet in the presence of alkalies. Other agents are also used to show, by color or its absence, whether there is an excess of lime in the softened water.

The lime process of softening water is extensively used in England, Germany, France, Austria, and Belgium, but, as Americans have been very backward in the matter of treating properly their boiler waters, its use in this country is very limited. The purest obtainable quality of quicklime should be used. Much of the ordinary "building lime" contains impurities such as flint, stone, burnt clay, etc.

This process is expressed chemically as follows:

Bicarbonate of Calcium		Hydrate of Lime		Carbonate of Calcium		Water.
	and		form		and	

$$Ca\,H_2\,(CO_3)_2 + CaH_2O_2 = 2\,(Ca\,CO_3) + 2\,H_2O$$

Notwithstanding the apparent simplicity of this process, it requires great care to conduct it successfully. Should an excess of lime be added, it certainly will form a scale as troublesome as that which it is the purpose of the process to prevent,—in some cases, indeed, a harder and worse one.

The use of soda for the purification of water is called the soda process; either caustic soda (hydrate of soda) or carbonate of soda may be used, and separately or together.

In the treatment of water containing simply bicarbonate of lime, caustic soda alone should be used, but this treatment is not as desirable as the lime process already described, being neither as cheap or as efficient, and not as easily handled. Caustic soda, on being exposed to the air, rapidly absorbs moisture, becoming a soft slush, and, when it comes in contact with the hand, it dissolves the skin by its caustic power, causing painful sores. Notwithstanding these drawbacks, it is very useful in water purification when other impurities appear.

The reaction which takes place when a solution of bicarbonate of calcium is treated with caustic soda is shown thus:

Bicarbonate of Lime and Caustic Soda form Carbonate of Calcium and Carbonate of Soda and Water.

$$Ca\ H_2\ (CO_3)_2 + 2(Na\ OH) = Ca\ CO_3 + Na_2CO_3 + 2H_2O$$

In other words, the carbonate of calcium is precipitated, while the carbonate of soda remains in solution; very little of the latter will be precipitated at ordinary boiler temperatures, provided the boiler is "blown off" occasionally to prevent the solution from becoming too dense by concentration. This solution of carbonate of soda is very useful in water holding any of the sulphates. Great care must be observed in using caustic soda. If used in excess, it causes a boiler to foam badly, and also readily attacks the fittings.

Next let us consider the carbonate of magnesium or, more properly speaking, the solution of bicarbonate of magnesium found so frequently in boiler waters. The methods of its removal are practically identical with those of removing bicarbonate of calcium, but this salt is not generally turned into the monocarbonate of magnesium ($Mg\ CO_3$) when chemically treated, but into the hydrated oxid ($Mg\ H_2\ O_2$). When water containing bicarbonate of magnesium is heated to 180° F., the greater part is precipitated as a monocarbonate, and at a temperature of 290° there remains in solution in the water only a fraction more than two grains of monocarbonate of magnesium to the gallon, and a part of even this small quantity may disappear in the presence of carbonate of lime. This decomposition frequently proceeds even further, more carbonic acid being expelled, leaving behind magnesium hydrate. This acts in the scale as a powerful cement, especially when sulphate of lime is present.

The reaction that occurs when bicarbonate of magnesium is treated by the lime process is expressed by the following formula:

Bicarbonate of Magnesium and Hydrate of Calcium form Carbonate of Magnesium and Carbonate of Calcium and Water.

$$Mg\ H_2\ (CO_3)_2 + Ca\ H_2O_2 = Mg\ CO_3 + Ca\ CO_3 + 2\ H_2O$$

The precipitate, then, consists of carbonate of magnesium and carbonate of calcium. Both hydrate of magnesium and hydrate of cal-

cium may be formed, if their respective carbonates are deposited on such parts of the boiler as are presented to the higher temperatures. In such cases these salts lose their carbonic acid, thus leaving the oxids, which soon unite with water and form the hydrates.

It is not advisable to treat bicarbonate of magnesium with the soda process, unless sulphate of calcium or of magnesium is also present.

We now come to the consideration of bicarbonate of iron. This, practically speaking, is the only form in which we find iron in natural waters. The solution is not a stable one; it decomposes rapidly on boiling, and slowly when exposed to the air, giving a reddish precipitate of hydrated oxid of iron (or iron rust). This salt is sometimes largely removed by splashing the water over rocks or twigs in such a way that the air comes in contact with the largest possible surface, thus hastening this process of oxidation and rapid deposit of iron.

Bicarbonate of iron can be treated by the lime process, but, if so treated, it easily yields up all its carbonic acid, and eventually is precipitated as hydrous oxid of iron, coloring the entire precipitate yellow. This hydrous oxid is very insoluble in water.

Next to the carbonates, sulphates occur most frequently in boiler waters, chief among them being sulphate of calcium. Probably no scale has proved more destructive or troublesome in steam boilers than that resulting from the precipitation of this salt.

The sulphates are formed when sulphuric acid acts on the metallic oxids, which it readily does. Most of them are very soluble in water. In nature we find sulphate of calcium widely distributed, either occasionally in the anhydrous state,—*i. e.*, uncombined chemically with water,—as the mineral anhydrite, or, more commonly, hydrated, as gypsum. Gypsum is sometimes known under other names, according to its crystalline structure,—selenite, satinspar, alabaster. When gypsum is heated to a point between 230° and 250° F., it loses three-quarters of its water rather quickly, and becomes the well-known plaster of Paris. The anhydrous sulphate is nearly insoluble, but the hydrated, with water at 95° F., dissolves in the ratio of 148 grains to the gallon. Its solubility in water at other temperatures is shown below.

At	32°	F.	120	grains	per gallon
"	68°	"	141	"	" "
"	122°	"	147	"	" "
"	158°	"	142	"	" "
"	212°	"	127	"	" "
"	240°	"	10.5	"	" "
"	250°	"	9	"	" "

" from 248° to 302° it is practically insoluble.

When the temperature of the water is raised above 302° F. (corre-

sponding with 55 pounds' gage pressure of steam), practically all of the sulphate of calcium will be precipitated.

The hydrous sulphate of lime is dissolved in water by the solvent power of the water itself, and not through the agency of carbonic acid or any other gas, and thus mere boiling at atmospheric pressure is not sufficient to cause it to be precipitated. For this reason it gives what is known as permanent hardness to water.

When the hydrous sulphate of calcium is precipitated, it loses one half of its water of crystallization, and, on reaching the heated boiler plate, it loses the other half. Thus it becomes anhydrite, and it is this change in crystalline form which binds the deposits previously precipitated into hard, compact masses.

Owing to the great solubility of sulphates, they occur very frequently in water that has made a passage through the earth. If we could trace all our solutions of sulphate of calcium to this direct source of supply, we doubtless would be troubled little, comparatively speaking, by this salt. Sulphuric acid is frequently present, in the free state, in rain and other natural waters, as has already been explained. This acid not only acts readily on the metallic oxids (converting them into sulphates), but also decomposes carbonates with the greatest ease, expelling the carbonic acid with effervescence; thus, when acting upon carbonate of calcium, it transforms it into sulphate of calcium.

When water containing free sulphuric acid passes through limestone districts, either subterranean or on the surface, sulphate of lime is thus formed by the mere splashing against the limestone rocks.

Sulphate of lime is also formed when waters containing free sulphuric acid are mingled with waters containing solutions of bicarbonate of lime, an exchange of the carbonic acid for sulphuric acid taking place. This sometimes happens in boilers when certain chemicals are introduced.

In treating water containing sulphate of calcium, the first step must be the conversion of the salt into the insoluble carbonate of calcium. The lime process is in no way applicable to the treatment of sulphate of calcium. Here the soda process is most applicable; either caustic soda or carbonate of soda may be used, and separately or together. When carbonate of soda is used alone, there should be no free carbonic acid or bicarbonates present, as these would furnish the carbonic acid necessary to form the soluble bicarbonate the moment the insoluble monocarbonate of calcium appeared. This trouble is avoided by adding sufficient lime water to absorb the excess of carbonic acid gas.

The reaction taking place when the carbonate of soda is used is shown in the following formula:

Sulphate of Calcium and Carbonate of Soda form Carbonate of Calcium and

$$Ca\,SO_4 + Na_2\,CO_3 = Ca\,CO_3 +$$

Sulphate of Soda.

$$Na_2\,SO_4$$

The carbonate of calcium, being insoluble, is precipitated, while the very soluble sulphate of soda remains in solution at all temperatures reached in boiler practice. It can be precipitated only by concentration, but an occasional opening of the blow-off cock will prevent this. This reaction is somewhat sluggish; for rapid precipitation it needs the assistance of heat. This use of carbonate of soda is not as satisfactory as the use of caustic soda, which is more energetic, rendering heat less necessary to the production of good results. In using caustic soda, great care should be observed to avoid an excess, as it will cause no little trouble from foaming, and, when concentrated, will attack the brass and copper fittings of the boiler.

Soda, as well as a few of the other very soluble salts, has a strange way of passing through the seams and joints of boilers, notwithstanding the fact that these are made absolutely tight for steam and water. This is especially true when these salts are somewhat concentrated. I have seen large deposits of these salts collected around cover joints, and in one case recently, actual stalactites had been formed, hanging like icicles from the joints through which this solution had oozed.

In nature we find magnesium sulphate ($Mg\,SO_4$) occurring in the minerals kieserite ($Mg\,SO_4H_2O$) and epsomite [$Mg\,SO_4+7\,(H_2O)$]. Kieserite is found in the Stassfurt salt beds, and epsomite in many of the limestone caves in minute crystals mingled with the earth; in the Mammoth Cave, Ky., it adheres to the roof in loose masses, like snow-balls. It has also been found as a coating on the walls of gypsum quarries. Kieserite is not easily soluble, and, as it occurs so seldom, it is scarcely worth attention. Epsomite is very soluble. It is identical with the well-known cathartic, epsom salt.

The supply of sulphate of magnesia directly from the mineral is very limited, the greater part of the solutions found in natural waters being formed by the contact of sulphuric acid with magnesium oxid or with carbonate of magnesium in a manner closely analogous to the formation of sulphate of calcium.

It occurs, however, in boiler waters far less frequently than any of the impurities we have thus far discussed, and its behavior is very different from that of sulphate of calcium, largely on account of its much greater solubility at all temperatures, and especially of the rate of increase in its solubility as the temperature is raised. Sulphate of magnesium is not corrosive or injurious to the boiler parts, and does not cause foaming; therefore, by itself, it cannot be considered very

objectionable; but, when present with lime salts, it is often troublesome, hindering their removal. To illustrate this, let us suppose that we have a solution of both sulphate of magnesium and bicarbonate of calcium. To precipitate the latter, we introduce a solution of hydrated oxid of calcium (lime water). This acts on the sulphate of magnesium as well, as shown in the following formula:

Sulphate of Magnesium and Hydrate of Calcium form Hydrated Oxid of Magnesium.

$$Mg\,S\,O_4 + Ca\,H_2\,O_2 = Mg\,H_2\,O_2$$

and Sulphate of Calcium.

$$+ Ca\,SO_4$$

Thus is produced the very objectionable sulphate of lime, and with it is precipitated the hydrated oxid of magnesium, which will make much harder scale than the original water would have made.

Soda certainly should have been used in this case, in preference to lime. Carbonate of soda occasions the following reaction in cold water:

Sulphate of Magnesium and Carbonate of Soda and Water form Carbonate of Magnesium

$$5\,(Mg\,SO_4) + 5\,(Na_2\,CO_3, + 10\,(H_2\,O) = 4\,(Mg\,CO_3),$$

and Hydrated Oxid of Magnesium and Sulphate of Soda and Carbonic Acid and Water.

$$Mg\,H_2\,O_2 + 5(Na_2\,SO_4) + CO_2 + 9\,(H_2O)$$

As the sulphate of soda and carbonic acid remain in solution in the water, the precipitate will be $4\,(Mg\,CO_3)$, $Mg\,H_2O_2 + (H_2O)$.

In treatment with carbonate of soda, enough lime water should be added to combine, not only with the carbonic acid, but also with the carbonic acid in the carbonate of soda, thus partially producing a caustic soda. This treatment, however, is inferior to the treatment with caustic soda. Where the steam pressure in boilers exceeds 225 pounds, a new complication may be looked for when sulphate of magnesium and bicarbonate of calcium are present together, as, according to Collet, these salts react upon each other at a temperature of 392° F., carbonate of magnesium and sulphate of calcium being precipitated.

In boiler waters we frequently find one or more of the metallic chlorids present, such as chlorid of sodium (Na Cl), chlorid of magnesium ($Mg\,Cl_2$), chlorid of calcium ($Ca\,Cl_2$), and chlorid of potassium. Chlorid of sodium is simply common salt, such as is used in flavoring food. It is very soluble at all temperatures, increasing slightly as the temperature is raised, as may be seen by the following table:

At 32°	Fahr.	20,849	grains	NaCl	dissolved	per	gal.
" 68°	"	21,014	"	"	"	"	"
" 122°	"	21,598	"	"	"	"	"
" 167°	"	22,182	"	"	"	"	"
" 194°	"	22,767	"	"	"	"	"
" 220°	"	23,349	"	"	"	"	"
" 239°	"	23,640	"	"	"	"	"

Chlorid of sodium is frequently found in boiler waters, though seldom in large quantities. Its source of supply is very great. Immense deposits are found in many parts of the world, in the form of rock salt. It also occurs very widely distributed in smaller quantities, mixed in shales and marls, and frequently associated with gypsum, anhydrite, clays, and sandstone.

It is the principal solid constituent of sea-water, and many boilers located near the coast find in their water-supply chlorid of sodium coming from wells, inlets, rivers, etc.

Owing to the great solubility of "salt" in water, it, theoretically, will not be precipitated to form a scale until after it has been so concentrated that more salt will be found in each gallon than that contained in the saturated solution (as shown in the table). Practically, more or less salt is usually found (in small quantities) in nearly all scale where salt is contained in the water, even though a saturated solution is not approached.

Salt solution, like soda, has a persistent way of working through joints. I have seen this "leakage" continue until considerable deposits of salt had formed on the outside of the boiler.

Salt water for boilers has not been treated chemically by any practical methods. It can be used safely in a boiler with frequent use of the blow-cock, by which its density can be kept well above the point of precipitation. It is necessary to watch the density of such water in the boiler very carefully by use of a special hydrometer. This system, unfortunately, causes more or less waste of fuel, on account of the considerable quantity of hot water necessarily wasted in the blowing-off process, and this has led to the putting-in of condensing apparatus in such steam plants, by which all the steam that can be collected, after use, is condensed, the condensed water being then used in the boiler. An apparatus known as an evaporator is sometimes used, in which the salt water is heated by the use of steam from the boiler, and the fresh water distilled off is carried to the boiler. The salt and other solid matter that may be left behind in the evaporator is easily removed periodically. This apparatus is generally used to furnish "make up" water, in connection with the condensing plant. The steam which is lost by waste, etc., is thus replaced.

Unfortunately, exhaust steam from engines, pumps, etc., frequently carries oil with it, which is apt to accompany the condensed steam (or water) into the boiler, where it is a source of much trouble.

A solution of the chlorid of magnesium is frequently found in boiler waters. Of all scale-making substances, there is probably none so productive of corrosion as this one. The affinity of the magnesium and chlorine being very weak, these elements are separated at

nearly all boiler temperatures and pressures, hydrochloric acid being given off and magnesium hydrate remaining behind. Magnesium hydrate is very frequently found in boiler-scale, partly formed by the action just described, and partly from the precipitation of magnesium carbonate, which then loses its carbonic acid and forms the hydrate.

The formula showing the decomposition of the chlorid of magnesium and the description of the following corrosive action was given in the first article on this topic. Chlorid of magnesium is always present in sea-water, and in the inland seas and salt lakes. Water from brine springs almost invariably contains magnesium chlorid in solution. It occurs in the water of other springs.

When magnesium oxid, or carbonate of magnesium, is dissolved in hydrochloric acid, magnesium chlorid is produced, and doubtless this action takes place in nature, and is responsible for at least a portion of this supply.

Magnesium chlorid is very soluble in water: thus

At	32° F.	30,470	grains	$MgCl_2$	dissolved	per	gallon.
"	60° "	75,882	"	"	"	"	"
"	212° "	213,645	"	"	"	"	"

If this were a more stable salt under boiler temperatures, it would give but very little trouble, owing to its great solubility. When present with a solution of chlorid of sodium, it is much less liable to decomposition, and for this reason it has been suggested that salt be added to water containing magnesium chlorid. Fortunately many waters contain sufficient carbonate of calcium to neutralize the hydrochloric acid by their alkalinity, and by this means corrosion is often avoided.

Collet recommends the treatment of chlorid of magnesium in the same manner as sulphate of magnesium. He states that lime will precipitate the hydrated oxid of magnesia, and leave the chlorid of calcium in solution. "Provided that there is no sulphate of magnesia remaining in the water so treated, the chlorid of calcium will not give rise to scale or deposit, and is not objectionable." "There are, however, very few cases where chlorid of magnesium can usefully be treated with lime alone, and, practically, only soda is used for this purpose."

Chlorid of calcium, besides occurring along with chlorid of magnesium, the mineral tachhydrite ($CaCl_2 + MgCl_2 + 12H_2O$), is much more widely distributed in the mineral apatite [$3\,Ca_3(PO_4)_2 + CaCl_2$]. Analysis of boiler waters very seldom shows any large quantities of this salt, three or four grains per gallon being a maximum, while smaller quantities are more frequently found. It is generally present in the waters of springs and rivers, and consequently in sea-water.

The chlorid of calcium is very soluble: thus

At 32° Fahr. 29,186 grains Ca Cl_2 dissolved per gallon.
" 60° " 38,525 " " " " "
" 212° " 90,475 " " " " "
" 356° " 189,713 " " " " "

No scaling trouble will result from the presence of this salt in boiler water (due to the solubility increasing with the temperature), provided the solution is not allowed to become too greatly concentrated. It is, however, unfortunate that, when the chlorid of calcium becomes concentrated at a high temperature, its contact with the iron causes decomposition, and the chlorine attacks the shell. When this salt is present with sulphate of magnesium, a reaction is liable to take place, the sulphuric acid (in the sulphate of magnesium) replacing the chlorine (in the calcium chlorid), and forming the corrosive chlorid of magnesium and the scale-making sulphate of calcium.

The treatment of the chlorid of calcium should be the same as that of sulphate of calcium, the reaction, when carbonate of soda is used, being:

Chlorid of Calcium and Carbonate of Soda form Carbonate of Calcium and Chlorid of Sodium

$$Ca\,Cl_2 + Na_2\,CO_3 = Ca\,CO_3 + 2\,(Na\,Cl)$$

Chlorid of potassium occurs in boiler waters even less frequently than chlorid of calcium, and generally in less quantity. It occurs in a number of the mineral springs, and a small amount is found in sea-water. It is very soluble at all boiler temperatures, and no scale will be precipitated, unless the solution is greatly concentrated.

The nitrates in boiler waters are seldom a source of trouble. They are simply salts of nitric acid, and include nitrate of calcium Ca $(NO_3)_2$, nitrate of magnesium Mg $(NO_3)_2$, nitrate of sodium (also called Chili saltpeter, Na NO_3), and nitrate of potassium (also called saltpeter, or niter, KNO_3). These are seldom present in greater quantities than 3 grains per gallon; more frequently the quantity is less than 1 grain. All nitrates are easily soluble in water. They often are formed by neutralizing nitric acid with an oxid or carbonate, and nearly all nitrates may be formed by dissolving the metal in nitric acid.

The nitrates of calcium and magnesium occur so seldom and in so small quantities in boiler waters that they may generally be considered of little consequence. Owing to their great solubility, they cause, directly, but little scale or corrosion.

The nitrates of sodium and potassium are even more soluble, and,

in this country, it is but rarely that we find them producing injurious effects. In large quantities, their action on the plates of a boiler is very corrosive, particularly when a nitrite is also present, as, by continued boiling, nitrous acid is given off, and caustic soda formed, rapidly attacking the fittings.

Silica is sometimes found in solution in boiling waters, though in very small quantities, seldom reaching 1 grain per gallon. Quartz and flint are well known forms of silica, and most of the sands are composed of it. It is practically insoluble by itself, but the presence of soda or potash in the water (especially if the water is hot) causes it to dissolve in small quantities. Ordinarily, on account of the small amount held in solution, it is deposited only in small grains in the other scale, but, where present in any considerable quantity, or where, from long use of the boiler without cleaning, it forms any appreciable percentage of the scale, it makes it hard, resisting, and troublesome.

In some of our western States, in certain localities, the only available waters for boiler use are found to contain strong solutions of alkalies and borax. The action that follows their use in boilers is so destructive that it is advisable to condense all the available steam in surface condensers, and thus use this water over and over again. In such localities the use of evaporators is strongly to be commended.

Some of this troublesome water will yield to chemical treatment, and, in case no other water is available, it will generally pay the user well to seek the advice of an expert, who may be able to reduce the resulting troubles very materially.

A comparison of analyses, showing the salts dissolved in various waters, is the best method of studying their relative values for boiler use. For this purpose I select three analyses made by Vivian B. Lewes, each of which represents an average of the waters of its class. They give the salts found in springs, rivers, and sea-waters, in grains per gallon.

	Spring.	River.	Sea.
Carbonate of calcium	13.53	8.96	2.76
Carbonate of magnesium	1.11	1.04	trace.
Sulphate of calcium	4.46	2.49	77.36
Sulphate of magnesium	0.77	0.00	120.03
Chlorid of sodium	2.19	1.49	1536.11
Chlorid of magnesium	0.56	3.49	183.06
Silica, alumina, &c.	0.19	0.22	trace.

Of all salts found in sea-waters none give greater trouble in boilers than the sulphate of lime. It is much more soluble in a saline solution, such as sea-water, than in fresh water, but, when such a solution is concentrated, or when its temperature and pressure are raised, its solubility decreases very rapidly.

As has been stated, this salt becomes totally insoluble between the temperatures 248° and 302° F., either in salt or fresh waters.

Owing to this unfortunate fact, sea-water should never be used in modern high-pressure boilers, as, with steam at 55 pounds' gage pressure, the temperature of the water in the boiler is 302°, and of course this is increased as the pressure rises. It is plain, then, that the sulphate of lime will be precipitated as soon as it enters the boiler.

It may be well to give at this point two analyses of scale formed from sea-water, made by Prof. Lewes.

	No. 1.	No. 2.
Carbonate of lime	nil.	0.97
Carbonate of copper	1.11	nil.
Sulphate of lime	90.84	85.53
Chlorid of sodium	1.41	2.79
Hydrate of magnesium	0.75	3.39
Silica	0.85	1.10
Oxids of iron and alumina	0.24	0.32
Organic matter	2.96	nil.
Moisture	1.84	5.90
	100.00	100.00

Prof. Lewes has (in his "Service Chemistry") considered the effect of concentration of the saline solution of sea-water as follows: "If ordinary sea-water be concentrated, three distinct stages of decomposition may be traced:

"(1) Deposition of basic carbonate of magnesium.

"(2) Deposition of carbonate of calcium with remaining traces of the basic carbonate and hydrate of magnesium; and, finally,

"(3) Deposition of sulphate of calcium.

"Whilst the variation in the saline constituents of the remaining liquid may be seen from the following table:

SALINE CONSTITUENTS PER CENT.

Density	1.029	1.05	1.09	1.225
Chlorid of sodium	2.6521	4.4201	7.9563	23.8689
Sulphate of lime	0.1305	0.2175	0.3915	none
Carbonate of lime	0.0103	0.0171	none	none
Carbonate of magnesium	0.0065	0.0032	none	none
Chlorid of magnesium	0.2320	0.3865	0.6960	2.0880
Sulphate of magnesium	0.1890	0.3150	0.5670	17.0100
Water	96.7796	94.6406	90.3882	57.0331
	100.0000	100.0000	100.0000	100.0000

"If the sea-water be heated and concentrated above a density of 1.225, the salt commences to crystallize out."

Sulphate of calcium, although more soluble in a dilute solution of salt than in fresh water, yet "reaches its maximum solubility at a

density of 1.033, and, after this point, concentration of the saline solution diminishes the amount which can be held in solution, and the sulphate of calcium is perfectly insoluble in a saturated brine."

The treatment of sea-water by chemical methods is not at all practical. The great space required by purifying apparatus and the large amounts of caustic soda and carbonate of soda required would make it too expensive and inconvenient a process, and, even after treatment, thorough boiling would be necessary.

As the use of untreated sea-water is unquestionably bad in high-pressure boilers, we must resort to the use of surface condensers and the evaporator, to supplement the unavoidable waste of steam. Chemicals may often be used to assist in the work done in the evaporator. Many engineers, finding that deposits of oil in boilers are far less liable to occur in water having a density greater than that of fresh water, are inclined to use sea-water in connection with water from the condensers and evaporators. This is not good practice.

Brackish water, although not as bad for boiler use as sea-water, gives a great deal of trouble, and for similar reasons; therefore it should not be used in boilers. The character of its deposits may best be shown comparatively, by the following analyses by Prof. Lewes:

	River.	Brackish.	Sea.
Carbonate of calcium	75.85	43.65	0.97
Sulphate of calcium	3.68	34.78	85.53
Hydrate of magnesium	2.56	4.34	3.39
Chlorid of sodium	0.45	0.56	2.79
Silica	7.66	7.52	1.10
Oxids of iron and alumina	2.96	3.44	0.32
Organic matter	3.64	1.55	trace
Moisture	3.20	4.16	5.90
	100.00	100.00	100.00

It is dangerous to feed a boiler with one of these waters after the other. This generally produces violent foaming, or else the sudden breaking-up of one kind of scale previous to the formation of another.

This broken scale often falls in comparatively large pieces on the sheet immediately over the fire and causes overheating; sometimes it falls between tubes, interfering seriously with the circulating currents. This action nearly always occurs when pure water from the condenser is fed into a boiler previously containing scale, and is termed among engineers "rotting out scale."

Brackish waters are often found a number of miles back from the mouth of a river, and may then yield readily to treatment with chemicals, but in such cases all the water needed should be obtained during the ebb tide.

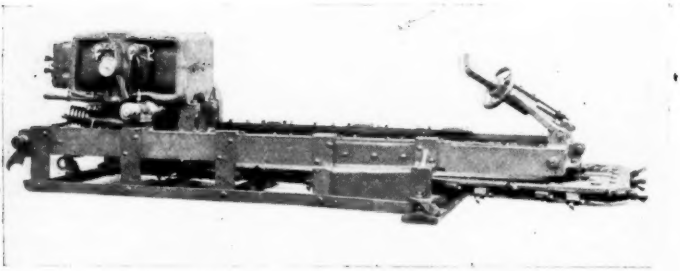
THE GROWING EFFICIENCY OF MODERN MINING MACHINERY.

By Cyrus Robinson.

THE amount of coal produced in the United States in 1895 was 193,117,530 tons, valued at $197,799,043. Of this 57,999,337 tons were Pennsylvania anthracite, valued at $82,019,272. This shows a production of bituminous coal of 135,118,193 tons, with a value of $115,779,771 on the cars at the mines.

About 15,000,000 tons of this bituminous coal was undercut, or mined by machinery, the mining, on a conservative estimate, costing the coal companies ten cents per ton less than that of the coal mined by hand,—a net saving of $1,500,000.

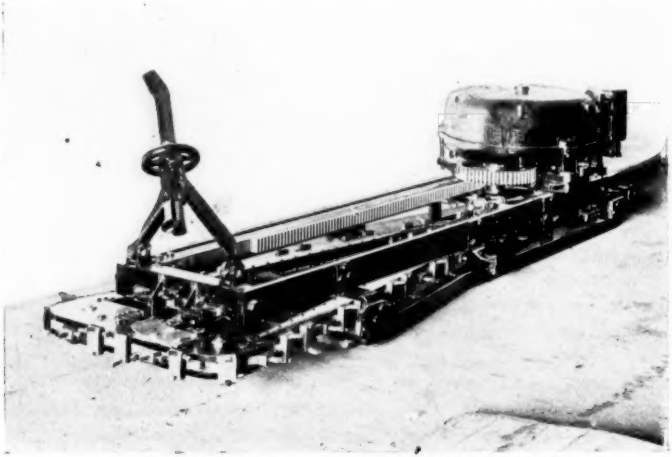
From these figures we may safely conclude that mining machines not only are established, but are an excellent investment. Many manufacturers of mining machinery advertise that a saving of from eighteen to twenty cents per ton can be effected by mining coal with their machines. This statement is incorrect, because incomplete, as can be readily shown. Pittsburg is undoubtedly the largest bituminous-coal center in the country, and, for illustration, the rates and prices obtaining there will serve our purpose. The mining rates agreed upon some time ago between the coal operators and miners were as follows; for pick mining, hand, 75 cents per ton, for which sum the miner undercuts the coal, drills and shoots it, and loads it into the mine car at the face, ready for the driver to take away to the tipple; where machines are used, 38 cents per ton is paid for drilling, shooting, and loading, 15 cents per ton for undermining the coal with the pick type of machine, and 9½ cents when the undercutting is done with the "breast" machine. Therefore we have a cost of 53 cents per ton for loaded pick-machine coal, or an apparent saving of 22 cents per ton, while, with the breast type of machine, the apparent saving is 27½ cents per ton. If this saving could be realized by substituting machinery for hand labor, we should expect to witness the closing of mines that cannot afford to put in machinery; but, as fifty per cent. of the apparent saving is practically consumed in operating expenses, and as thirty-five per cent. of the balance must be credited to interest and depreciation, the net saving is reduced nearly to 10 cents per ton, which in itself makes a good return on the investment. Therefore every coal operator would introduce power mining machinery, were it not for the fact that in many mines adverse conditions are encountered with which no machinery yet invented can cope.



"BREAST" MACHINE WITH DIRECT-CURRENT MOTOR.

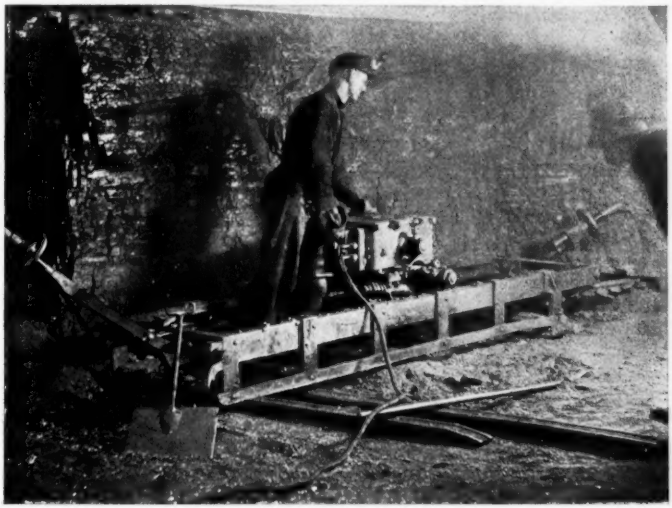
While, under specially favorable conditions, no other type of coal-cutting machine that has been built up to the present time can compete with the "breast" machine, it must be acknowledged that the pick machine—or "iron man," as it is sometimes called—is suited to a much larger number of mines and greater variety of conditions. To offset this advantage, there are a number of features that at present militate against the extensive use of this type of machine, such as a smaller saving in the cost of mining, the necessity of powerful and skilled men to operate the machines, and the fact that, up to the present time, no really satisfactory machine of this class operated by an electric motor has been placed on the market.

At this point it is well to touch briefly on the subject of power



"BREAST" MACHINE WITH THREE-PHASE INDUCTION MOTOR.

transmission in mines. This branch has been very fairly and thoroughly covered in the series of papers written by Mr. Rankin Kennedy, reviewed in the December (1896) issue of THE ENGINEERING MAGAZINE, and, in the writer's opinion, the principles laid down, although peculiar to English operations, may serve as a guide for general equipments in this country. Mr. Kennedy's paper agrees with one presented by me at the joint meeting of the Western Pennsylvania Central Mining Institute and the Ohio Institute of Mining Engineers, held at Pittsburg in June, 1896, in concluding that the electrical system is superior, as a whole, to any other system of transmitting power. Affording as it does a maximum of flexibility and



"BREAST" MACHINE IN OPERATION.

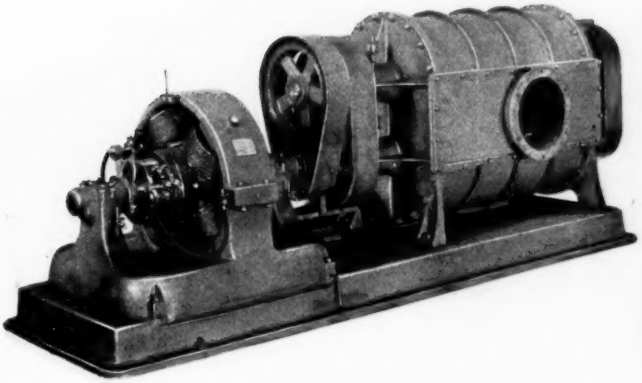
simplicity, and rendering it possible to use successfully one generating plant for furnishing power to all parts of the mines and for all purposes, such as coal cutting, drilling, lighting, pumping, hoisting, haulage, fans, screens, conveyors, etc., the advantages of such a system, with its consequent reduction in the cost of operating the plant, must be apparent at once to the mind of any business man. That this is the case is shown by the large number of mines in this country operated throughout by electrical machinery.

As in other branches of the electrical industry, a great deal more work has been done in this country than abroad in the application of electricity to mine work. Although I have not the statistics at

hand, I may state with approximate accuracy that, out of the 212,000,000 tons of coal mined in Great Britain in 1895, not more than 750,000 tons were mined by machinery. Probably it would surprise Mr. Kennedy to learn that during the past year over $1,000,000 worth of electrical machinery has been installed in coal mines alone in the United States, and that fully ninety per cent. of this was for coal cutting, and at least $400,000 worth of compressed-air machinery has been furnished for coal cutting, and the coming year promises to see still a larger business. Among the reasons for this is the fact that for some years past the mining of bituminous coal in the United States has not, as a whole, been a lucrative business. Carefully-prepared statistics of the coal industry of 1895 show that, on an actually invested capital of $320,000,000, not more than 3½ per cent. was cleared, and it is not surprising to note the active interest being taken in methods and machinery that will increase the returns on the enormous investment. Unfortunately for a number of coal operators, particularly the smaller ones, the conditions in their mines practically prohibit the successful use of such machinery as is at present on the market, and the introduction of machinery by their more fortunate competitors can naturally be followed by one result only,—the wiping out of the small profit that they are at present obtaining,—unless some one in the meantime come to their rescue with a machine that will cope successfully with the conditions.

In this paper prominence is given to the mining machine, or coal cutter, as it is the agent which, if properly used, effects the greatest single saving. Other electrical machinery, though effective in reducing the expense, is by no means as effective as this. In the majority of mines it would not pay to install an electrical plant for haulage alone. The apparent saving might, in some cases, reach three or four cents per ton, but, as the depreciation which has to be written off every year in mining plants is great, this saving is generally offset.

It is unfortunate that the consulting engineer is not used more by coal companies considering the installation of a plant, to technically advise as to the purchase. As a rule, the officers of a mining company are not mechanical or electrical experts, and have only a general knowledge of the appliances on the market. At present the engineering work for these plants is done by the representatives of the various manufacturing companies, and, as each is desirous of securing the order, there is a great temptation to recommend a plant made up of the smallest possible units for the work. This is particularly noticeable in regard to the conductors or pipes for transmitting the power. The writer frequently has been astonished to find his competitor for a plant proposing a conductor of about one half the carrying-capacity re-

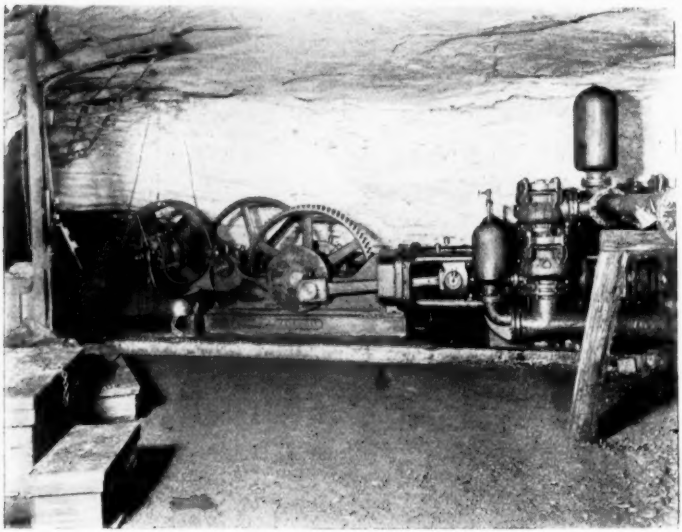


ROOT BLOWER DRIVEN BY SLOW-SPEED MOTOR.

quired, stating to the coal company that it was very foolish on the part of anyone to aim at high efficiency in a coal-mining power-transmission plant, as coal was cheap at a coal mine. It is not the coal alone in this case that should be considered, but the increase in the size of the generating plant made necessary by the proposed excessive loss of power in transmission. In my experience, the average dealer in this class of machinery never thinks of compensating for the great loss in the line by increasing the size of the generating plant; consequently he is able to offer a cheaper all-round plant, and, if he gives a strong enough guarantee, he oftentimes succeeds in capturing the contract. When the plant is installed, it starts under a strain, and in many cases fails to do the work guaranteed; delays, bad feeling, and generally a compromise result, the purchaser having probably lost twice as much by the delay as the services of a competent engineer would have cost him, besides not having a plant adequate for his present requirements, let alone the future. These troubles are noised abroad, and the blame is placed, not in the correct quarter, but on mining machinery in general, consequently rendering it almost impossible to secure another order in the district for some time—generally not until the plant in question has been rebuilt in many respects. When it is considered that the average mining plant, for a mine producing one thousand tons of screened coal per day of ten hours, costs approximately $20,000, this figure covering coal cutting, haulage, and drilling, it seems that the purchaser, for his own protec-

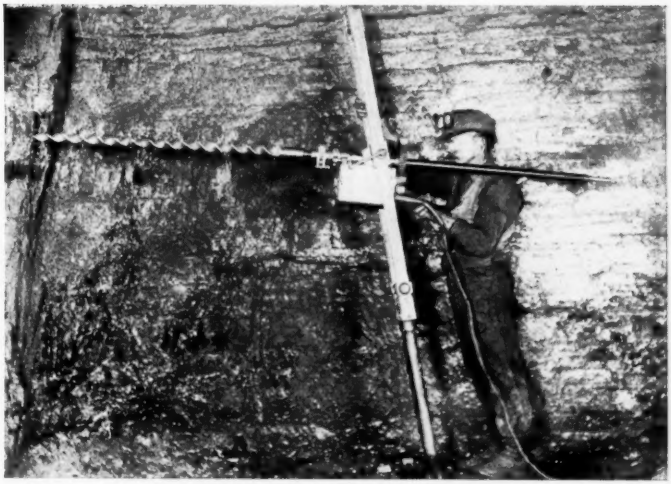
tion, ought to secure the services of a competent engineer first to determine the requirements from the conditions in the mine, and later to superintend the installation of the plant.

A few facts concerning the machinery illustrated in this paper are of interest. Two of the coal-mining machines illustrated are of the type known as breast machine; the third as the pick machine, or "iron man." Another cut shows the breast machine at work in a room in the mine, and very clearly illustrates the method of operation. An average day's work of ten hours, for a machine of this type, is one hundred feet, lineal face, under cut from five to six feet; this



ELECTRICALLY-DRIVEN DEEP-MINE PUMP.

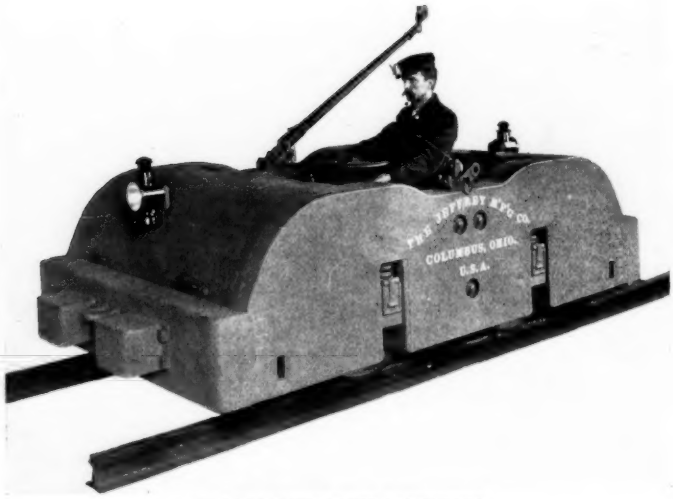
average cannot be obtained, except with clean coal, even and regular horizontal formation of the vein, and, above all, good roof. This last condition is essential to the successful working of the breast machine, as will be readily observed from the illustration of the machine at work. If the nature of the roof is such that the timbers, or props, must be placed close to the face, the efficiency of the machine will be greatly reduced, and, in many mines, where the roof is very faulty, they cannot be used at all; so that it becomes necessary to resort to the pick machine, which, being much lighter and of a purely portable construction, enables the miner to work between and around the posts, in about the same manner that he would with a hand-pick. With the



ELECTRIC COAL DRILL IN OPERATION.

pick machine an average man will undercut from 60 to 75 lineal feet face of coal from 3½ to 5 feet under, per day of ten hours. He will, however, in doing this, make from three to four times as much fine coal as the breast machine, due to the difference in the shape of the cut, it being necessary for the pick machine to make a wedge-shaped mining, tapering from a height of twelve to sixteen inches at the front, or face, to a height of about ten inches at the back of the cut.

BALDWIN ELECTRIC MINE LOCOMOTIVE.



JEFFREY ELECTRIC MINE LOCOMOTIVE.

GENERAL ELECTRIC MINE LOCOMOTIVE.

Peculiar as it may seem, the breaking up of so much coal by the pick machine is a decided advantage to the coal company in districts where the mining rates are based on screened coal, as the coal cuttings going through the screens represent a clear gain of mined fine coal to the company. The coal miner, however, is partly compensated by the increased price paid for mining with this type of machine.

The coal drill illustrated, which was designed by the writer, has come into extensive use in connection with the mining machines of both types, particularly in Ohio, Illinois, and West Virginia. One of these machines in the hands of a man and boy will drill a sufficient number of holes to shoot down 600 tons of six-feet coal per day of ten hours; and, as the saving is about one cent per ton, the purchase of a drill makes a very excellent investment. Even in mines where the coal is very soft, such as the Pocahontas, this saving can be realized, and the system of having all the coal drilled by one man results in a much better grade of coal, as the driller becomes expert in placing the holes to best advantage for shooting the coal with the least amount of powder.

I have chosen three types of electric mine locomotives as illustrating the present practice. The first two shown were designed by me for the Jeffrey Manufacturing Company and the General Electric Company, and the other is the product of the Baldwin Locomotive Works. The Jeffrey and the General Electric locomotives, although much alike, have distinct differences in the arrangement of the parts. The General has the operating platform on one end, while the Jeffrey has it in the center; the former has the advantage of placing the motorman within easy reach of the coupling-pin, when going in one direction, and, if the switches are properly arranged, the efficiency of the locomotive is materially increased; while the latter gains in having the man better protected in case of a collision or runaway, and in a more even distribution of weight on the drivers, as well as a shorter machine. This latter feature is a very decided advantage in mines where the curves are of short radii and the entries narrow.

Both locomotives are equipped in other respects in about the same manner as an ordinary electric street-car truck, having one motor on each axle, with single reduction spur gearing. This construction has both advantages and disadvantages; among the former may be included simplicity, low first cost, small number and interchangeability of parts, and chilled cast-iron drivers; among the latter is inability to obtain the same tractive power from both axles, it being practically impossible for two electric series motors to divide a load equally between them, connected as they necessarily are on a machine of this

type. This trouble is largely overcome in the Baldwin locomotive by coupling the drivers, but, in securing this advantage, the excellent features of the first type are lost. Mining camps are the last places in the world in which to install complicated machinery, if it can be avoided, and, in designing machines for mine service, it is necessary to sacrifice many features otherwise highly desirable, in order to obtain simplicity. One of the principal reasons causing me to adopt the construction that obviates the necessity of coupling the drivers was the great difficulty in getting the drivers turned down at the mine when it became necessary. Besides lack of proper facilities, there is another serious trouble, common to all locomotives operated with an overhead trolley and track return,—namely, the sparking between the rail and the face of the drivers, which has the effect of hardening the faces of the wheels, so that, after a few weeks of service, they become so hard that it is practically impossible to turn them with a tool, making it necessary to grind them down,—an expensive and very troublesome operation. Another reason was that at the majority of mines there are but poor facilities for lifting quickly the heavy weights that have to be handled, whenever the drivers are replaced. A locomotive so constructed that this is not necessary has a decided advantage.

To determine the size of locomotive required, the only safe way is to make a number of tests, with a dynamometer, of the drawbar-pull required to haul the cars in the mine where the locomotive is to be used, there being so wide a difference in the track and car construction in different mines that, in the writer's experience, he has never found it safe to more than approximate the size required before making the test. He has found the required drawbar-pull to vary all the way from twenty pounds per ton to fifty and, in extreme cases, as much as seventy-five. The rules laid down for surface railroad practice will not apply in mine service. On the average surface road there is a comparatively clean rail, while in a mine the rails generally have a coating of moist coal dust, which is an excellent lubricant, so that in mine practice it has been found necessary to use a factor of eight for determining the weight required on the drivers from the drawbar-pull, instead of five, which has been found sufficient for surface work. Some of the worst failures in electric mine haulage have been caused by neglecting to have sufficient weight on the drivers.

Other illustrations accompanying this paper—of pumps, hoists, and blowers—serve to show the great variety of uses to which electric motors are put, in and about a mining operation.

STREET-CLEANING IN PARIS AND BERLIN.

By Robert Grimshaw.

IT was remarked at a recent public meeting in New York that the citizens, having once tasted the advantages and conveniences of clean and unobstructed streets, would never consent to a return to the old order of things, where filth and all manner of obstructions were allowed to encumber the public ways. For years the one unpleasant feature of the American's return from abroad was the sudden contrast offered by the streets of his native cities to those which he had just left on the continent. So the same feeling that New Yorkers are beginning to cultivate, in taking it as a matter of course that the streets should be kept clean, has become an ingrained public sentiment in the cities of Europe, and especially is this the case in Paris and Berlin, the method of the cleaning of whose streets should be of moment to all who are interested in municipal affairs.

Here are two cities, one with a population of 1,800,000 and the other with a population of 3,000,000, where the two things that make the first and strongest impression upon the visitor are the immense street traffic and the extreme cleanliness of the road surfaces. The blinding dust that we have regarded as an unavoidable nuisance is unknown in Paris, despite the fact that its streets are so constantly crowded with surging humanity and the horses and vehicles necessary to administer to its business and pleasure. Yet so efficiently and unobtrusively is the cleaning of the Paris streets accomplished that one forgets the existence of the corps of workers, and comes to look upon the city as resembling those homes that are always in order.

The work of maintaining this order and cleanliness of the streets was formerly under the control of the prefect of police, but in 1859 it was transferred to the prefecture of the Seine and placed in charge of the engineers of public streets,—a change of great importance when regarded from a financial standpoint, inasmuch as it lowered the annual expenses from $885,510 to $734,944, the latter being the figure in 1872. These expenses have risen since, however, reaching $1,250,290 in 1889.

The street-cleaning department may be said to work with four subdivisions: the first has to do with the purchasing and maintenance of materials; the second, with the employees; the third, with sprinkling; the fourth, with the removal of offal and rubbish.

Of the first little need be said. Its function is to buy tools and distribute them to the several sections, and, when anything is in

need of repairs, to replace it at once by a duplicate in good condition. At the present time the annual outlay of this division amounts to something more than $65,000.

It is with the second division that the public interest in the work begins, and, if we wish to watch it from the first stroke done in the day, we must be up betimes, for the work starts, year in and year out, at 4 A.M.

The first sweeping and scrubbing of the morning is done at the expense of the owners or tenants of the adjacent properties at the rate of about six cents per square yard, while the day cleaning is paid for by the city. The whole area cleaned amounts to 18,674,400 square yards, and the total tax is about $660,000

Both men and women are employed in the street-cleaning corps, which is divided into 149 brigades. In the heart of the city one of these brigades usually consists of a chief, one assistant, and twenty-five laborers who may be men or women. Of these the major portion work only in the morning. During the second half of the day "cantonniers" are employed, whose duty it is to clean the streets, urinals, police stations, markets, and cab-stands. In the outlying sections each brigade consists of a chief, four cantonniers, and from fifteen to twenty sweepers, the latter being employed in the afternoon only, except in bad weather. The pay of these employees, of whom there are about 3,200, varies with their efficiency, and is placed at the following rates per hour:

Strong men	6½ to 7½ cents.
Old "	6 cents.
Women	5½ cents.
Children	5 cents.

A chief of the first rank of cantonniers receives about $25 per month, and the rank and file about $21, out of which each pays $1 into the savings bank, which is repaid with interest when he leaves the service. All employees are also compelled to maintain a specified accident insurance.

In the performance of the actual labor both the hand-broom and the sweeping-machine are in use. The latter finds its especial application upon stone-paved streets and in times of snow-fall, while the former is in use upon the asphalt and wooden paving.

The sweeping machines are heavy and of two kinds,—the Sohy and the Blot. The former has a cylindrical brush 75 inches long, and sweeps a strip 72 inches wide on the first trip, after which the parallel strips run from 48 inches to 64 inches in width. Thus, at a rate of travel of about 240 feet per minute, each machine will sweep 7,200 square yards hourly. The Blot machine has a shorter brush, not so

obliquely placed, so that it does not throw the material out as well as its rival, though the ground covered is practically the same. It is drawn by one horse.

It is on the asphalt streets that the great interest centers, on account of the thoroughness with which the work is done. The hand-brooms are of the "piassava," a tough South American palm fibre, whose botanical name is *Attalia funifera*. These brooms are about 16 inches long and 4 inches wide, and are built up of five rows of from fifteen to eighteen meshes, each 8 inches long. In addition to the brooms, the laborer has a rubber squeegee 32 inches long. In the early morning the hydrants are opened, and the asphalt is flooded,—flooded not merely by allowing the water to fill the gutters, but by throwing water from large wooden scoops over the whole surface of the street, until everything is loosened and ready to flow. Then the brooms and squeegees are brought into action, and the whole surface brought to a condition of almost absolute cleanliness. This is the main cleaning of the day, after which the work is light. Sprinkling or wetting down is always done by hose, watering-carts, scoops, or pots before the sweeping; in rainy weather the sweeping-machines may be used, and these are always followed by the hand-broom to bring the rows of refuse into heaps for loading into carts. Of course, in freezing weather the washing is omitted; then the work is done by a sweeping-machine in the afternoon. Gutter-cleaning follows each sweeping; the gutters are usually washed twice each day.

For the past few years the street-sprinkling has been done, in the main thoroughfares, by the cantonniers with a hose. Still, the watering-cart is extensively used, and there are 370 in service, drawn by horses, beside a number propelled by hand. The carts are the property of the city, a contractor furnishing the horse and driver at $68 per month. The sprinkling period begins between March 15 and April 15, and extends to the middle of September or October, according to the season and the kind of pavement, the total sprinkled area being 6,556,800 square yards.

As I have said, work begins at 4 A. M., and between that and 6:30 the sidewalks and streets are cleaned and sprinkled, sand is strewn on the asphalt, and the cab-stands are washed and disinfected. Then the sweepings are taken away, and cleaning resumed. Between 8:30 and 11 the streets are sprinkled with hose or watering-pot and re-cleaned, the public urinals are cleaned, and then comes the rest for breakfast, lasting till 1 o'clock. From 1 to 4 there are machine-sweeping, squeegeeing, and hand work; at 4 the work is ended, unless the weather requires overtime—to 5, 6, or even 7 o'clock.

The removal of the sweepings, which is quite as much of a task as

the sweeping itself, takes place, in summer, between 6:30 and 8:30 in the morning; in winter, between 7 and 9. About an hour before the arrival of the wagons, householders are obliged to deposit their refuse material in strong receptacles placed in the corridors, and these must be kept clean and in good condition, and must not exceed a specified weight. The removal of the sweepings costs about $400,000 per year.

The removal of street and house sweepings, fallen leaves, and vegetable and animal refuse from the markets is done by contract, not including, however, the removal of decayed vegetable and animal matter, dead animals, and offal and excrement, from the slaughter-houses. The contractor is at liberty to choose his own dumping-ground, subject, of course, to approval by the city authorities. The material is the property of the contractor, and what he cannot utilize he ships to a point about ten miles out of the city. Attempts to utilize as manure such animal matter as the intestines of chickens and rabbits, spoiled fish, etc., have not proved successful. The cost of removing this refuse can only be approximated, and is placed at from 57 to 63 cents per day per thousand inhabitants.

Many experiments have been made in disposition of fæcal matter. It has been used for agricultural purposes, and it has been cremated. To carry it away in boats involves the difficulties of low water in summer and ice-blockades in winter; for rail transportation the regulations are so strict and the freight charges are so high that seventy-five miles becomes a prohibitive distance, rendering its utilization in the barren places of Tarifen, Champagne, or Sologne impossible.

Cremation is expensive, as the English have shown, since the mere erection of the suitable plants in Paris would cost at least $1,200,000, and even then some provision would have to be made for the removal of the ashes; the carting could go on for only two hours a day, while the kilns would have to be kept red-hot continuously.

Paris is not often visited with a heavy snow-storm, and up to the winter of 1880 the snow was removed from sidewalks and courtyards by the householders, while the administration managed to get rid of the snow by means of carts obtained from the omnibus company, the garbage contractors, and other sources of supply. But a heavy fall of snow in 1879 brought out an ordinance that went into effect in October, 1880, under which every able-bodied laborer can, at the beginning of the winter, register himself as a snow-cleaner, whereupon he will be assigned to some specified place at which he is to report at every snow-fall.

The streets are classified according to the urgency existing for the removal of the snow. First, the wide streets, in which the snow is heaped into rows, with a clear space of from 16 to 24 feet in the mid-

dle. These piles, as the weather permits, are removed, made into one, or strewn over the roadway. Second, the narrow streets with a heavy traffic, where the snow must be entirely removed. Third, streets where the snow can be thrown into a single row, and allowed to remain until a thaw.

The best machine for snow-cleaning has been found to be the rotary sweeper, having a row of steel "bristles" between each two rows of piassava. Snow-ploughs have been used, but, though drawn by four horses and manned by two men, they have not fulfilled the expectations of the authorities. They are too heavy, and cannot be used in the heavy-traffic streets. Still, there are eighty-eight of them in use.

Salt was first used in 1880, and is said to give no trouble. One man takes it from the wagon, and it is spread about by means of a funnel in the hands of another. There are also some salt-strewing machines, but they have shown no advantages over hand-work. For a snow-fall of two inches about half an ounce of salt is required per square yard. The quality used is the coarse eastern, which costs about six dollars per gross ton.

The snow that is carted away from the ten wards bordering the Seine is dumped into that river, where there are forty-two dumping-places. Those wards which do not lie along the river use the gutters and sewers for snow-dumping, both hot and cold water being used to assist in rapidly carrying it away. As the removal of snow, even by the means described, would occupy too much time, a portion of the work is done by private contractors, the streets being divided into twenty-eight contract districts, each having a dumping-place in the Seine, the sewers, or elsewhere. So, when a specially heavy fall of snow occurs, all available municipal means are employed, and the contractors are set at work, their pay being based on the number of cubic yards removed, with results highly satisfactory.

The omnibus company is pledged to set fifty carts at work, and to haul something more than five thousand yards of sand to various parts of the city.

When the snow falls during the day, the cantonniers and extra laborers commence the cleaning of the city's sidewalks and roadways; the householders do the same before their houses; and every effort is brought to bear on those streets needing immediate attention. If it comes down at night, the snow ploughs first clear a space of 16 feet or 20 feet in width, and are followed by the sweeping-machines. When these are insufficient to remove the trodden snow, sand or salt is used, giving a partial relief to the traffic, after which the removal of the snow begins, and is pushed as rapidly as possible. When the greater portion of this work has been done, the streets of the second class are under-

taken, and then the third, unless a thaw has set in to render it unnecessary, in which case transportation is stopped, the hydrants are opened, and the snow is swept into the gutters by machines.

As for the total expenses of the Paris department, the latest figures available are those for 1891, when they amounted to about $660,000, —figures that are interesting from the fact that they represent work thoroughly, promptly, and constantly done, under all conditions of temperature and weather. No excuses are offered, and none will be accepted, for work imperfectly or intermittently performed. The merchants recognize the fact that clean streets represent profit, and dirty ones loss, and they would rebel in a week if the work of street-cleaning was in the least slighted.

Turning to Berlin, we have a city of about the same population as Chicago, but with what a difference in the appearance of the streets! In one cleanliness is assumed as the normal and only permissible condition; in the other—well, perhaps the less said the better.

In Berlin the work of cleaning the streets is done "direct" by the municipal government acting through a department, created nearly twenty years ago, that has charge of the cleaning of streets and squares, the removal of sweepings and other refuse as well as snow, and the sprinkling and maintenance of streets, public urinals, and closets. The area under its care amounts to about 8,000,000 square yards, of which about 35 per cent. is paved with stone and 15 per cent with asphalt. The personnel of the force consists of a director at a salary of $2,500 per year, 6 inspectors, 1 depot master, 22 district inspectors, 84 foremen, 450 first-class workmen, 70 second-class workmen, 90 helpers, and 28 stone-breakers, besides a tailor and carpenter, making 722 employees in all. The inspectors and depot-master receive from $600 to $700 a year, the laborers from 40 to 80 cents a day, and the foremen 94 cents. The laborers are supplied with uniforms free of charge, and in almost every instance the department pays half of their insurance against illness; they are not obliged to furnish their own tools, as most other laborers are, and are paid for Sundays and holidays. When they grow unfit for work, they receive a yearly pension based upon their length of service, ranging from $100 to $150.

The area to be cleaned is divided into six districts, and the work, without exception, is done by machines, of which there are forty-two. The manning, hauling, and maintenance of the machines are let to a contractor, who receives $1.50 per machine per working day. In addition to the forty-two regular machines, the contractor has nine extra machines, held in reserve for emergencies. The duty demanded of the machines is not stipulated, as it depends upon circumstances,

but it may be taken to range from 6,600 to 10,500 square yards per hour. The reason given for the use of the machines is that they do the work more economically than it can be done by hand.

The removal of the sweepings is also let to a contractor on a six-year agreement, at about $94,540 per year, which does not include the removal of snow. This latter is paid for by the load, but from the amount is deducted that which would be paid for the removal of the sweepings during the same length of time. The prices paid are 54 and 60 cents per load.

The carting of the street manure and sweepings, as well as the snow, is at the contractor's expense, and he provides his own dumping ground, being free to utilize or dispose of the materials. Removal of snow by melting has been unsuccessfully tried. The utilization of the street manure and sweepings is not as complete as might be desired; still, more than half is shipped by water from Berlin, and the contractor is supposed to realize a profit of about 25 cents a load.

It is well known that asphalt paving is more easily cleaned than any other, but it demands special treatment, because it is smoother and requires constant and uninterrupted attention in order to prevent accidents to horses and vehicles. Horse manure is especially dangerous, so that particular care has been directed to its prompt removal, thus reducing complaints to a minimum.

As Berlin has a larger percentage of asphalt paving than any other great city, especial attention has been paid, in considering street-cleaning there, to the best method of work with this type of road surface. In general, all streets regularly cleaned are sprinkled twice a day, but those that are particularly dirty are sprinkled three or even four times daily. An exception is made, however, in the case of the asphalt streets; these are not merely sprinkled, but regularly washed, every day, the pavement being first liberally sprinkled to soften the coating of dirt and then squeegeed, which dispenses with the necessity of a second washing on the same day. In view of the great extent of the asphalt, a considerable saving is thus effected. Mere sprinkling would not answer, as the layer of dirt would only be made more slippery and unsafe for horses. The sprinkling season extends from April 1 to October 1, costs about $56,000 a year, and uses about 215,000,000 gallons of water.

As I have said, the sweeping is done exclusively by machines with piassava brushes. These, as well as all other supplies for the department, are bought in the open market, and at an expense of about $15,000 a year, the wear and tear depending upon the season, being naturally greatest in winter. The total annual expenses of the department are about $405,000, from which must be deducted various

incidental receipts, amounting to about $31,000, leaving a total net expenditure of about $374,000.

A portion of the receipts is due to the obligation of the railroad companies to clean and sprinkle all streets in which they have their rails. Double-track streets must be cleaned for a width of 18½ feet, and single-track streets to half that width. The department, however, does this, the railway company paying three-fifths of the actual cost.

The sweeping-machines are mounted upon four wheels, with the brush between the two rear wheels and rotated from the axle. This rotation may be stopped without stopping the machine, and the brushes may also be lifted clear of the ground. The bevel wheels are protected by sheet-iron casing; the oil boxes have special dust covers; and the oil is carried to the journal bearings by wicks. The driver's seat is on springs; the lamps are hung on spiral springs. A brush lasts 225 hours, new "bristles" costing as much as a new brush.

The sprinkling-cart barrels are of sheet iron, .16 of an inch thick. They are cylindrical, and provided with two wrought-iron bands, and are carried on a wrought-iron frame. The filling is done through a full-sized man-hole, so that inspection, cleaning, and painting are easy. This man-hole is closed by a plate with a felt gasket. The cart is usually drawn by one horse, but may be fitted with a pole. The rear wheels carry the greater portion of the weight, thus facilitating the turning. The sprinkling valve is opened by a foot-lever, the tube being of wrought iron. It is easily cleaned, and the holes in it are carefully bored, so as to insure an equal distribution of the water, which is thrown over a strip about 14 feet wide. The maximum speed of hauling is about 380 feet per minute.

On all of the asphalt streets there are cast-iron receptacles for the sweepings. These are about 5 feet 10 inches high, 20 inches wide, and 14 inches deep. At the upper end they have a semi-circular sliding cover, and a door at the bottom. The contents are removed in wheel-barrows, the latter being of iron with wooden wheels and holding about 7 cubic feet.

Thus we see that, in the two greatest cities of continental Europe, the details of the practice of cleaning the streets are widely different, and yet the results obtained are practically the same,—clean streets at a reasonable expense.

REVIEW OF THE ENGINEERING PRESS

Bridge Accidents in United States and Canada in 1896.

A COMPILATION of statistics of bridge accidents for the past year in the United States and Canada has been compiled by Mr. Charles F. Stowell, and presented in *Engineering News* (Feb. 11) in tabular form, with comments. The lists do not include wooden bridges burned with no accompanying casualty. Neither do they include "an extremely long list of bridges carried away by floods, or bridges blown down without other damage to person or property." The accidents are named in three schedules,—those on electric railways, those on steam railroads, and those on highways. Thirty-seven are recorded as occurring on thirty-three different steam railroads, and as causing the death of fifty-seven people, and injuries to eighty-six more. On the electric railways, six bridge accidents are recorded as occurring on five roads, killing forty-six people, and injuring nine more. The proportion of deaths to the total number of bridge accidents on electric roads is, therefore, very much greater than that in the list for steam railroads. Whether this is a mere coincidence for the year, or whether it results from some cause peculiar to electric railways, is not made clear. A curious inference drawn by the author—to wit, that July is the most dangerous month in the year wherein to cross bridges, while June is the safest—rests on no better foundation than the events of a single year; and, if the observations of a single year were enough, it is not wholly clear from an inspection of the tables how this conclusion can be legitimately derived from the facts there noted. "Of the structures involved" (on the steam railroads) "eight were wooden trestles, seven iron or steel bridges, nine wooden bridges, and thirteen of unknown construction. On the electric roads one only of the bridges was a wooden trestle, one a stone arch, and there were four iron or steel trusses." On the steam railroads the accidents are classified as "five square falls, six destroyed by fire, five by freshets . . . three unknown. In one case the bridge was a Howe truss draw-span, which gave away in consequence of the breaking of the wire-lifting cables. The worst accident was at the Cahaba bridge in Alabama, where the rails had been removed by train-wreckers, causing a derailment which resulted in the destruction of the bridge." In this accident twenty-four people were killed and eleven others injured. The number of accidents with highway bridges was fifty-nine; the number of lives lost in these accidents was fourteen, while the number of people injured was fifty.

Clay as a Modern Building Material.

THAT a sort of revolution has been going on in the brick, tile, and terra cotta industries, during the past twenty years, has been obvious to observers of progress, but the extent of the change is hardly yet appreciated, even by builders. Architects, however, realize that the increased use of iron and steel in building construction has very materially affected the use of brick, tiles, and terra cotta, and they are, perhaps, outside of the manufacturers of these articles, the only ones who have an adequate idea of the nature and extent of the changes that have been quietly going on. Formerly, when bricks were used for the weight-bearing and floor-supporting parts of large structures, they were required to have great strength and solidity. Except for fronts, beauty was a thing hardly thought of. Now, as is pointed out by Mr. Henry R. Griffen in *Brick* for February, "lightness, durability, and beauty are the primary essentials." The only quality which the modern product is required to retain out of the former requisites and in an equal degree is durability. "In former days the clay work was the building; now it is the shell, the beautifying agent, and the protector of the metal frame. To-day

as many or even more brick may be sold for building construction as in the past, but they are sold under different conditions; the old contracts for brick by the millions for single buildings are rare, but, on the contrary, the demand for hollow building material has wonderfully increased, and, in fact, has grown from nothing into an enormous business within a few years." One of the clearest indications of the increased part ornamental clay work is to play in the future is the great extension in the output of clay-working machinery. No statistics of the growth in this line of machine-manufacturing are at hand, but it is safe enough to say that the growth has been remarkable and significant. "A few years ago the manufacture of enameled and glazed brick was in its infancy in this country, and there was some doubt as to its continued existence. To-day this manufacture is carried on successfully by several concerns, and the business is firmly established." One of the problems now engaging earnest attention is the production of glazed and enameled terra cotta, for which, Mr. Griffen tells us, there is already a demand. The demand existing, all precedent warrants the belief that the desired product will be forthcoming, especially as there appears to be no insurmountable difficulties in the way. Another article of modern origin and now in demand is the thin hollow block, glazed on both sides, for partition walls. So far the demand has not been satisfactorily met, but Mr. Griffen predicts a large business in this line when a product satisfactory in quality and quantity shall have been reached. The author does not attempt to outline the effects of these changes upon the lumber and other building-material trades upon which clay products are more or less encroaching; but he foreshadows some of these effects, when he speaks of a clay product in the future of such finish that coatings of plaster or cement will no longer be needed. The perusal of Mr. Griffen's paper presents to the mind of the observer of current events an active, energetic, aggressive industry, so much removed from the character of the brick manufacture of two decades ago as to fully justify the assertion that clay working in the manufacture of building materials has been revolutionized within the period named.

Shortage of Water-Supply in Brooklyn.

A VERY suggestive article by Mr. George E. Waring, Jr., in *Harper's Weekly*, upon "The Water Famine in Brooklyn," deprecates the prevalent tendency among water-works engineers to meet an impending shortage by resort to greater reaches and more distant supplies. The chances are ten to one, in most cases, that the impending shortage is the result of needless and even wanton waste, and that the existing supply is more than double that actually needed for necessary uses. No doubt houses and flats in Brooklyn could be found which, every twenty-fours, waste four gallons for every gallon necessarily used. We are not at all sure that instances of this kind would be comparatively few, and we are certain that instances of even more exaggerated waste are not infrequent. We have known of a case where constant flow through a flush-trap out of repair was allowed to go on for over a month, the stream thus going to waste being a large fraction of the full discharge capacity. This was in a row of flat buildings, and there is not the slightest doubt that this stream alone, running night and day, discharged more water into the drain-pipes than was necessary for the actual needs of the whole row. Therefore we can subscribe without any reservation to Mr. Waring's protest against this weak yielding to a great public vice—the careless and wanton waste of water.

"Water," says Mr. Waring, "must be 'as free as air,' and the people must be allowed to use it and to waste it at their own sweet will, no matter what it costs to supply them. Every attempt to check this tendency is frowned down, often by the very men who should be the first and most zealous in regulating use and in preventing waste." What he says further with reference to the present water-supply in Brooklyn is equally applicable to a hundred cities in the United States where people are clamoring for increased supply. "The simple truth is that Brook-

lyn has, in the works on which it is now depending, water enough to last it for every possible proper use for so many years to come that there is now no need even to consider a further source of supply. The millions it is proposed to spend to get more water may be saved by a proper application of relatively insignificant thousands for the prevention of waste." The principle here enunciated may be paraphrased mathematically by saying that the cost of rendering present supply adequate for all reasonable wants is to the cost for obtaining a supply for unreasonable demand and for wanton waste as thousands to millions. Thus stated, the principle is applicable to most North American municipal water-supplies. "It has come to be the prevalent notion," adds Mr. Waring, "that no town is safe—in this country, at all events—unless it has at least one hundred gallons per day for each person of its population. It is a fact, well-known to those who have made a study of the matter, that less than one-third of this amount would suffice for the most liberal needs of any community. This opinion is fully supported by English experience." The English are a people noted for their cleanly personal habits, and would be intolerant of any restriction in the right use of water; notwithstanding this, the daily water-consumption of Liverpool was twenty-three imperial gallons per head in 1881; and Mr. Waring quotes Mr. J. Parry, the Liverpool water-works engineer, as saying: "There is probably no modern city in which the legitimate demand for water and the facilities for using it are greater than in Liverpool. Water-closets are general, and it has long been a practice to supply baths in all houses of more than ninety dollars' annual rental." A diagram showing average rate of flow for the twenty-four hours of the day proves clearly that much of the waste goes on without the knowledge of the consumer. It shows that the flow continues at hours when the needed use of water is at a minimum, and at a rate which is clearly far beyond any demand that the population is making at such hours. In fact, the evidence that in American cities generally more water is wasted than is consumed is beyond all serious question. If influential engineers generally would take the same firm stand on this question that Mr. Waring has, there might be hope of reformation. The remedy is in a good system of inspection and the use of meters which register water wasted as well as that used. These means have time and again converted want into plenty, without any enlargement of supply.

Thermal and Mechanical Cut-Outs.

ONE of the commonest of electrical devices is the fuse; yet Prof. W. M. Stine, in a paper read before the Northwestern Electrical Association at Milwaukee January 21 (reported in *Western Electrician*, Feb. 20), says that some thought and study may yet be profitably devoted to it. He will hardly be contradicted in the statement that "the rational way of regarding a fuse in circuit, and of obtaining a just estimate of its protective value," is to consider each element of the circuit as a thermal cut-out to a certain extent, capable of fusion by the heat of the current provided this be pushed beyond the heat-resisting power of the element, and the fuse as a metallic element purposely introduced into the general circuit, and so related to all the other parts as to make it, as regards its heat-resisting power, the weakest part of the entire circuit, "its weakness being so adjusted that it shall yield before the other circuit elements are harmed." The final consideration in the proper adjustment of a fuse in a circuit must be given to that element of the circuit which, without the fuse, is the weakest. The fuse must be weaker than that weakest part, yet not so weak as to incommode by its too ready fusion. "Beginning with the generator, its armature has a known carrying-capacity, and one which does not admit of a great margin. This is also true of the motor armature. In the leads the need for thermal protection is slight; in branch and tap circuits it assumes a grave importance, increased by the uncertainty of joints and local corrosion. The transformer, again, offers much the same problem as the generator and motor." Mr. Stine notes

that, although so extensive and common use of the fuse wire was made, its "vagaries and uncertainties," up to a recent date, "became almost a by-word." . . The manufacturer of fuse blocks, beyond a change of material,—wood to porcelain,—had shown no satisfactory progress. The fuse wire had been investigated in a few laboratories, but in rather a casual and incomplete manner, and the results were confusing rather than instructive. In view of this unsatisfactory state of knowledge upon the subject, Prof. Stine commenced a series of tests about two years ago, the object being to obtain data and formulate "precise directions for the use and rating of fuse wires." Several thousand determinations were made, the principal points investigated being "the time element and uniformity of fusing, the carrying-capacity as influenced by length, diameter, and enclosure, the effect of use, and the influence of the receptacle." As the value of the time element may not be at once apparent, the author occupies a little space in its consideration. Uniformity of the fusing-point, also of great importance, is considered at some length. This part of the discussion is summed up in the following conclusions. (*a*) "Covered fuses are more sensitive, and have a lower carrying-capacity, than exposed ones." (*b*) "Fuse wire should be rated for its varying capacity for the lengths ordinarily employed." (*c*) "Fuse blocks should be made with greater distances between the terminals." (*d*) "Fuses should be removed from time to time, as they become coated or fouled." (*e*) "The time element should be considered when protecting parts which are liable to burn out." (*f*) "Fuses up to five amperes should be at least 1½ inches in length; one-half an inch should be added to the length for each increment of five amperes." (*g*) "Except for smaller sizes, flat fuses are more reliable than round wires." (*h*) "Round fuse-wire should not be applied in excess of thirty amperes' capacity. For higher currents flat ribbons exceeding four inches in length should be employed." The ordinary manner of making fuse wire is criticised as entirely inadequate. "Each spool of wire should be accompanied by a curve, or table, clearly setting forth the carrying-capacity for varying lengths." Prof. Stine goes still further, and recommends the discontinuance of the use of fuse wire, and the substitution therefor of "fuses already mounted to copper terminals, and plainly marked with their normal rating, which should be at 80 or 90 per cent. of their fusing currents." As compared with the action of mechanical cut-outs, the action of the fuse is extremely slow. The choice between these devices must, of course, depend more or less upon the conditions of service. For protecting motors, except in the smaller sizes, circuit breakers are preferable, fuses not being reliable. Simplicity should characterize all mechanical cut-outs. "The electro-magnet should contain but little iron, and the mechanism for opening the circuit should be powerful enough to secure prompt and regular action." In the tests of mechanical cut-outs the liability of the mechanical parts to fail through sticking has been found so small as to be negligible.

Pulleys Made of Paper.

THE less weight a shaft has to carry, the less will be the power it consumes in friction. The pulleys mounted upon shafts often form a considerable part of the weight the shaft bearings are required to support. If any part carried by these bearings be out of line, or out of running balance, the result of such defects upon the waste of power will increase with the increase of weight in the defective portion. In most cases it would be desirable to run shafting as light as is consistent with required rigidity, and pulleys as light as is consistent with the service they are needed to perform. The use of any material that could give an increase of cohesion, or, in the case of friction pulleys, an increase of adhesion, would be a distinct advantage, if this gain could be made without sacrifice of other essentials. From this point of view experiments made by Mr. Geo. D. Rice, with paper as a material for pulleys, the results of which he communicated to *The Iron Age* (Feb. 11), are not without interest, and may prove of importance to the mechanical world. The

pulleys experimented with were of two kinds, one of paper pulp compressed between metallic flanges, and the other made up on the lag principle. In the first-named kind the flanges have hubs, which may be attached to the shaft by set-screws or keyways, and the paper filling between the flanges is attached to the latter by a series of through-bolts inserted at a uniform distance from and parallel with the axis of rotation of the pulley. In this form the paper filling between the flanges is an integral disk with a hole in the center; in the second the lags are of the form which would be obtained by cutting the above-described paper disk into two semi-cylindrical parts by a plane passed through the axis of rotation. The clamping between the flanges is done in the same way for both forms of pulleys. Two different kinds of paper stock were used, one kind for the first form of pulley, and another for the second form; but we do not gather that this is required as a consequence of the different construction of the pulleys, and suppose, rather, that the modification was merely for experimented purposes. It seems that the stock found best for one form would also be best for the other. "The stock for the disks was made from ordinary straw boards, which, after being compressed, was cut into disks, cemented with a special glutinous mixture, clamped in the flanges, turned down, treated to a coating of wax and tallow, smoothed, and polished. The stock for the lags was made from a combination of book and rag material, received in pulp form and pressed into molds." The reduction in bulk by compression (shown by a diagram accompanying the article) appears to be nearly two-thirds of the mass put in the mold. Repeated applications of pressure were required to condense the paper to a degree that qualified it for use in drive-wheels. After compression, the lags were heated to 210° F. in an oven, and kept at this temperature for fifteen hours. The residual moisture was thus dried out. The lags were next bolted to the flanges, turned in a lathe, and treated with the dressing made of wax and tallow, above mentioned. Sand-papering and polishing finished the wheels. A special machine was made to test these wheels. This machine and its application are illustrated and described in Mr. Rice's article. We note here a few of the results. The two types of construction produced wheels capable of withstanding about equal pressure (550 pounds per square inch), without yielding. At 775 pounds' pressure per square inch one of the wheels was crushed. Under a pressure of 165 pounds per square inch an increase of resistance to slipping of twelve per cent. in the paper as compared with leather surfaces was shown. "Over one surface iron, one wood and the other paper, one raw hide and the other leather, there was an increase in favor of paper each time. In another experiment a 6-inch leather belt was run on 20-inch pulleys at a speed of 900 feet per minute, developing 10 horse-power with a slip of 6 feet per minute when subjected to sprays of steam from jets . . . which was done to find out the action of the paper surfaces under the influence of steam." A flanged rim and spoke pulley with paper lagging between the rim-flanges gave, it is said, good service.

The construction of this pulley is peculiar. The rim and also the spokes down to about half the radius are split in a plane at right angles with the axis of rotation. Through-bolts pass through holes in the spokes. When the nuts of these bolts are screwed tightly down, the two divided parts of the rim are forced toward each other, thus clamping the paper lagging between them. We incline to the belief that there may be a future for these wheels. We have no means of comparing their cost with that of iron pulleys, but can not see that they can be materially cheaper; we should judge, on the contrary, that their cost might exceed that of metal pulleys.

Strength of Timber.

THE continued acquisition of data on this subject was noted in the remarks of Mr. Walter G. Berg in the course of a discussion at the sixth annual convention of the Association of Railway Superintendents of Bridges and Buildings, held in Chicago in October, and printed in the

report of the proceedings of the convention issued during the past month.* Those desirous of obtaining references to the latest literature and data of the strength of timber will be aided by Mr. Berg's remarks. After noticing the wide and favorable attention given by the technical press to the previous year's report of the committee of the association upon "Strength of Bridge and Trestle Timbers," he names additional data which have become available since the publication of that report. These are as follows: Bulletins No. 10 and No. 12 of the United States department of agriculture, division of forestry, the first entitled "Timber," the second entitled "Economical Designing of Timber Trestle Bridges." The latter contains the 1895 report of the committee, above referred to. The "Mechanical and Physical Properties of Southern Pine" are treated in Circular No. 12 of the department of agriculture, and a bulletin on the "Principles and Practice of Dry Kilns" is announced as in preparation. In *Engineering News*, June 25, 1896, are published extensive data of tests carried out by Mr. William Hood, chief engineer of the Southern Pacific Railway. Extensive tests of Pacific coast timbers have been in progress during the past year in the department of civil engineering of the University of California. Republished from the *Technological Quarterly* in pamphlet form, are now available the "Results of Tests Made in the Engineering Laboratories of the Massachusetts Institute of Technology." Results of tests of Washington fir and eastern white oak made by Mr. O. D. Colvin for the Northern Pacific railroad are contained in the *Railway Review*, March 7, 1896. Notes on white pine timber are also to be found in the issue of that journal for March 28, 1896. *The Inland Architect* for August, 1896, contained an article by F. E. Kidder on "The Proper Unit Stresses for Timber," which was republished in the *Railway Review* in its issue of October 3, 1896. The proceedings of the twenty-ninth annual convention of the American Institute of Architects (held last summer at St. Louis) comprise notes on the strength of timber by Mr. George W. Bullard of Tacoma, Washington, and by Prof. J. B. Johnson of Washington University, St. Louis. Lastly, Mr. Berg presents a straight-line formula adopted by Mr. J. E. Greiner, a member of the association, for the new 1896 issue of the "General Specifications for Bridges and Buildings of the Baltimore & Ohio Railroad," to which he adds a diagram showing various formulæ for yellow pine columns in comparison with actual, full-size tests, which diagram embodies data comprised in a similar diagram published in the proceedings of the American Society of Civil Engineers. For Mr. Greiner's formula and his reasons for its adoption, the printed proceedings of the convention above named may be referred to. Mr. Berg has done a public service in thus collating the references to the more recent data, at a time when engineers are so actively engaged in investigation of the subject.

* "Strength of Various Kinds of Timber Used in Trestles and Bridges, Especially with Reference to Southern Yellow Pine, White Pine, Fir, and Oak."

Municipal Plants.

THE issue of *The Electrical Engineer*, for February 17, is largely devoted to an exposition of the views of electrical engineers upon, and a broad review of, the subject of the municipal control of electric-lighting plants, in which it takes the position hitherto maintained by THE ENGINEERING MAGAZINE that neither experience or logic warrant the belief that the public would get better service by an extension of the system of municipal control. It holds that a general adoption of municipal control and operation of electric-lighting plants would be adverse to the interests of the public. The data presented in confirmation of this view are extensive, and, we think, ought to be convincing. The candor and willingness of our contemporary to give both sides a show is manifested by the presentation of what is perhaps one of the ablest efforts on the side of the partisans of municipal plants, a report of Commissioner A. E. Winchester of South Norwalk, Conn., who has collected data from some three hundred mu-

nicipal undertakings. Mr. Winchester is very highly complimented for his ability as a municipal officer and his skill and acquirements as an electrical engineer. Notwithstanding, his report is not convincing. "In most instances the balance-sheet is decidedly unfavorable, and in many cases there appears to be no knowledge that such a vital factor as depreciation must be taken into account. Even Mr. Winchester, stanch champion as he is of municipal plants, is slow to approve of them for large cities." He appears to think there is a higher standard of official morals in country towns than in the greater commercial centers, which may be the fact; but, if it be desirable to maintain this standard, the surest and quickest way to destroy it is to multiply opportunities and temptations to wrongdoing by extension of the system of municipal operation. We hardly intended this notice to do anything more than direct public attention more strongly to the good work of our contemporary, an adequate review of which could not be made in the space at our command. The editorial and other matter relating to the subject in the issue named should be itself consulted to gain a broad idea of the present attitude and arguments of those favoring, as well as of those opposing, what is fitly styled "the municipal-plant craze."

The Copper Mines of Arizona.

PROF. ARTHUR LAKES, in *The Colliery Engineer and Metal Miner* for February, has an interesting description of the mineral resources of Arizona, dwelling more particularly upon the deposits of copper, which he declares to be "the largest and finest we know of in the west," adding that "Arizona is a country not too well known, nor over-advertised for its mineral wealth." Attention is directed to the large increase in the output of precious metals in Arizona. The yield of gold from her mines was $4,260,000 in 1895, or quadruple the output for 1893. Mr. Lakes predicts that "at the end of the next fiscal year the production of gold in Arizona will have reached $10,000,000," basing this prediction upon "the large number of new gold discoveries, the rich developments being made, and the number of reduction works being erected, as well as the enthusiasm displayed among prospectors and the eagerness of capitalists in gold mining." What is true of the progress in the mining of gold and silver is true of the copper output. A field of great promise has been opened within forty miles of Tucson. Large deposits of sulphid of copper exist "in the region of the Grand Cañon . . . which only await the advent of transportation facilities to become large producers." A copper mine which, it is predicted, will yield copper bullion for a century to come is located at Bisbee, Cochise county. "These mines and smelters are worked night and day, and employ 1,000 men. The average daily output is 37,000 pounds. Large copper deposits and mining industries exist also in Gila and Maricopa counties; but the most phenomenal mine of Arizona, as well as of the west, in its way, is that of the United Verde (gold, copper, and silver), producing 150 tons daily. A letter from a prospector is quoted as saying that, with the big machinery,—150 tons' capacity,—there is ore in sight in this mine for 150 years. The output in 1894 is stated to have been $1,500,000 in gold, $7,500,000 in silver, and 11,000,000 pounds of copper. Strange as it may seem, this rich mine is very little known to the outside world. The prospector quoted, who signs himself C. A. R., asserts that people not more than twenty miles distant from the mines know only that there is a mine located there and being worked, but have no idea of the great wealth of the deposit. He makes some astonishing statements as to profits, which we prefer not to reprint, as we do not know how far they are warranted by facts.

Fast Long-Distance Run—A New Record.

THE possibilities for higher speeds on railways have found another demonstration in a special run made on February 15 over the Chicago, Burlington & Quincy and the Burlington & Missouri railroads, from Chicago to Denver. A detailed description of this run, with editorial com-

ments, is given in *The Railroad Gazette* Feb. 26). The special train consisted of an engine and a private car, chartered by a gentleman who was very anxious to reach Denver before the death of a son lying dangerously ill in that city. The train left Chicago at 10 A. M. For this special service one dollar per mile was paid, the distance being 1,025 miles. No guarantee for the time in which the run should be made was given. It is said that the intention was to run about as fast as the fast mail trains. Only after the train was well on into Iowa was a record run decided upon. Orders to run as fast as consistent with safety were then given. Twenty-one station stops were made between Chicago and Denver, these stops, in the aggregate, consuming sixty-four minutes.

Deducting this aggregate from the total time between the two points, the actual running time was 17 hours and 49 minutes, the average speed being 54.27 miles per hour. There are, as our contemporary points out, some very significant features in this performance. No special preparation was made, or even thought of, in connection with it. "Generally, in preparing for a special fast run, a season of the year is chosen when suitable weather is assured, and the track is in the best condition. The locomotives are carefully chosen and put in good order, special arrangements are made that the track shall be clear far in advance of the train, and all officers and employees are notified to be in their proper places. Often watchmen are stationed at grade crossings along the line, . . and main track switches spiked. Everything which could cause delay is anticipated." The remarkable performance above noted is characterized by the entire absence of special preparation. The train started in a snow-storm, hauled by an engine that had been fifteen years in use and was recently employed in the freight service." In view of all the facts, *The Railroad Gazette* is right in styling the feat "a triumph of discipline." Only careful organization and training throughout all departments could have rendered it possible.

Continuous Records of Marine Engine Performance.

IN no department of engineering are exact data more necessary than in tests of marine-engine performance. After every trial of a new steamship, a mass of data are recorded, and, if the ship be one of importance, these data are generally printed in the technical journals in connection with a more or less detailed description of the engines. In this form they are generally looked upon as of sufficient accuracy to indicate what may be expected in continuous running. Prof. W. F. Durand, in *Journal of the American Society of Naval Engineers* for February, asserts that such data are far from furnishing information from which a "continuous record of performance can be deduced." The indicator cards are not taken with sufficient frequency. Ten- to fifteen-minute intervals are too long, giving too much room for variation in mean effective pressure, and the counting of revolutions for one minute out of fifteen can not give a very close approximation to the mean number of revolutions. The margin of possible error in a single minute's counting always involves a fraction of one turn, and, unless experience and care are applied to the counting, it may reach a still larger figure. Prof. Durand, therefore, advocates a reform in the method of conducting tests. He shows—satisfactorily, we think—that indicator cards must be taken at five-minute intervals to insure that the error shall be not greater than one per cent., and that this degree of accuracy can be relied upon by the use of methods of procedure which he prescribes. We cannot attempt to give these methods in detail here, but shall note their general character. In dealing with mean effective pressure, an experimental determination of a general relation connecting the mean effective pressure with the initial pressure and vacuum is first made; next, a continuous record of the vacuum; and from this record and the previously-determined relation a continuous record of the mean effective pressure may be determined. The continuous record of the vacuum and the initial pressure is easily secured by the

use of recording gages. Prof. Durand says that "the relation sought must be determined by experiment, and consists, in fact, of a calibration or standardizing trial, in which the steam pressure and vacuum will be determinately varied, and indicator cards will be taken." He illustrates this by an example which shows it to be easily practicable. The method of interpolation enables the record to be completed for all values of initial pressure and vacuum between the limits of the observations. In the absence of recording gages, gage readings each quarter of a minute will enable a close approximation of initial pressure and vacuum to be made. The continuous record of revolutions may be made by a recording tachometer. "In default of such instruments, we may, instead, read the counter every quarter or half minute, putting down the numbers in succession, but making no attempts at subtraction to find the differences." Now, in these procedures and operations Prof. Durand shows that absolute accuracy is not so important and desirable as "relative correctness of value. With correct relative values and the true total integration of the revolutions, as given by the counter . . . the record derived may be made correct, both relatively and absolutely," and, "this being done, we shall have continuous records of both mean effective pressures and revolutions, and hence, by their combination, a continuous record of the work and power in each end of each cylinder, and hence, by summation, a continuous record for the power as a whole." The exposition of the method is followed by an account of its application to a trial of the engine power of the steam yacht Clara on Cayuga Lake. The yacht has a length of 91 feet, a beam of 11.9 feet, a draught of 3 feet 5 inches, and a displacement of 40 tons. The engine is compound, having cylinders 10 inches and 19 inches in diameter, and a 12-inch stroke. The record of this trial is an interesting study. The value of the mean power was found to be 105.23. A comparison of this with results obtained by cards taken off at intervals in the usual way shows not only wide differences depending on the time interval between cards, but also wide differences between the results of the tests made at the different time intervals. Out of a number of examples we cull two striking ones. "With intervals of fifteen minutes, the first card being taken at seven and one-half minutes from the beginning of the run, we have 115.3 as the mean power. With intervals of fifteen minutes, the first card being taken at the beginning of the run, we have the value 95.7. There is a difference here of 19.6 between the results of the two tests; while, as compared with the result obtained by the continuous-record method, the first of the two tests gives a result 10.07 too large, and the second gives a result 10.16 too small. Only when cards were taken at intervals of not more than from three to four minutes was the error reduced to less than one per cent. During the trial the fluctuations of conditions were such as would not ordinarily be met with." The author admits that this makes the range of error in the trial of the Clara more than usually wide. The paper concludes with a consideration of changes of condition most likely to occur between the calibration and actual trial. Plottings of results are given upon infolding plates.

Principles of Design.

MUCH that is written upon the subject of architectural design must appear mere rubbish to professional as well as lay readers. Given a certain familiarity with the technology of art, a facility acquired by practice in what we may style the cant of art literature (for there is such a thing as cant in art talk as well as in religious and moral discourse), and a vivid imagination, trained or otherwise, and it is easy to dash off something almost or quite worthless, which nevertheless may impress the shallow reader as profound. It is pleasant to say that a paper on "The Principles of Design" by W. A. Langton, in *The Canadian Architect and Builder* for February, is not of this superficial character. The author has something to say that is really helpful, and says it tersely, clearly, and without affectation. He first alludes to those principles in design—as, for example, "honest construction and truth to

material"—which, as he forcibly expresses it, "approach to moral qualities"; but he immediately dismisses this as a trite topic, and turns to the "details of handling in search of rules or principles which may be guides to help the eye in matters of taste, just as an elementary knowledge of perspective is often a guide to the eye in drawing an object, when it is difficult to decide by the eye alone whether a line is horizontal or sloping, or which way it slopes."

Thus it is possible to discover a law of fitness(for example, in the proportion between capitals and columns, or between capitals and piers) which will prove at least a rough guide to design. This idea is elaborated and illustrated by reproduced drawings which exemplify the principle of fitness as applied to the design of a capital and base; showing that, in the effort to produce such a design, thought is directed to the expression of the use of a capital in a beautiful manner rather than to emphasis upon its structural usefulness and the way in which it is useful,—to wit, as a means for concentrating a large load upon a small shaft. However, a design proceeding in this manner does emphasize the structural facts, but this appears as a concomitant result rather than a principal purpose. "Where there is small superincumbent weight, it is more pleasing to have the column small and even fantastic. For instance, in the Lombardic fronts of Pisa and Lucca, where the columns stand over one another for ornament and support nothing, it would cease to be ornamental, and be merely dull, if they were sober, business-like columns, instead of being what they are,—small inlaid, twisted, knotted, composed of a pile of animal forms, or even with the upper and lower parts looped together, as if for tension." The capital not being strong transversely, the deep bell form becomes essential for small columns, etc. Heavy caps on piers, having no expression, are condemned as a mistake in design. With reference to round and flat arches also the author discourses intelligibly and sensibly, illustrating this part of the paper with drawings and diagrams, and bringing out, among other principles, that, "as a rule, in masonry what looks strong enough has an excess of strength, so that, if we are to make an arch look right, we must go beyond the consideration of statical needs, and give some consideration to artifices by which the curved lines of the arch (the chief indicators of its restlessness) may be composed. One of these is uniformity in the springing line. This is a point often disregarded when the arches, though visible together, are not close together. When the openings form a regular arcade, the need of making the arches spring from the same line is clear; but it does not seem to be so clear that there should be a springing line for each story, just as definite as lines of strings and cornices which indicate the floor and ceiling levels. It is not a question of real stability, but one of repose, gained by the composition of lines, and, though ample piers may be between them, arched windows which spring from below the heads of square-headed windows in the same story can never be as pleasing as those which spring from the level of these heads." This fault is as objectionable in interior as in exterior design, and the old colonial style is named as presenting many good examples of the right treatment of round and square-headed openings. As the author puts it, "the difference between simple expression and artistic expression is that one lays the facts before us, leaving us to find out for ourselves what they are," while the other "puts them in such a way that they strike at once, without one's having the trouble to think at all. That is what makes the artist. He is not content until he has expressed the matter so that it will impress some one else." The means at the disposal of the architect for this end are reviewed, and useful hints relating to their proper treatment are presented. While there is always something to express, there is not often much, and "in all cases minor things must be subordinated, and the principal expression given to those which are important."

THE BRITISH PRESS

The Promise of the American Iron Trade.

ONE of the most significant recent movements, of joint interest to the metallurgical, mechanical, and commercial world, is the promised development of an American export iron-trade.

It is not unnatural that the expectation on this side of the water should be often over-enthusiastic, nor, on the other hand, that British comment should show a tendency toward undue slighting of the importance of the matter. It is, therefore, of particular interest to notice the thoughtful and dispassionate review of the situation which is afforded by so eminent an authority as J. Stephen Jeans, in an editorial entitled "The Lights in the Window," published in a recent issue of the *Iron and Coal Trades Review*.

Mr. Jeans briefly reviews the "considerable amount of talk, and probably not a little alarm," which has been occasioned in some quarters of Great Britain by the threatened success of American iron and machinery firms in securing control of large European orders. "Some of the daily newspapers," he continues, "have deemed it worth while to give an unusual amount of attention to the subject, and one of them at least has spoken of the American imports of iron and steel as causing a scare in iron-making circles here. There is hardly sufficient truth in this exaggerated manner of putting the case. We do not believe that many of those who really know the facts are apprehensive that we shall suffer much harm from the threatened deluge of American iron and steel. We may, however, experience periodical visitations of the same sort of panic. We did so upwards of a hundred years ago, when attempts were made to induce parliament to stop the importation of iron from our American colonies. American competition loomed largely in the mental horizon of Richard Cobden when he wrote, more than fifty years ago, that it was to the industry, the economy, and the peaceful policy of America, and not to the growth of Russia, that politicians and statemens of whatever creed ought to direct their anxious study, for it was, he said, by these, and not by the efforts of barbarian force, that the power and greatness of England were in danger of being superseded. The danger which Cobden then foresaw, with a rare prescience, is, no doubt, more imminent to-day than it has ever been before, but it is not, for that reason, irresistible."

But yet, Mr. Jeans admits, "the Good Ship 'British Industry'" is in some danger, and watchfulness is needed to keep her off the "rocks of apathy and inadequate preparation for meeting new conditions. There is no gainsaying the fact that certain American firms, and more especially the Carnegie Steel Company, have, by recent business deals, become the masters of enormous stores of cheap raw materials, as well as of cheap transport. By great engineering talent and unique administrative capacity, the same concern has succeeded in blotting out the differences in the cost of labor that previously hindered American manufacturers from hoping to land American products on European soil. The only difficulty now standing in their way is that of space. Situated nearly four thousand miles from the markets they aim to conquer, it would appear, on the first blush, utterly impossible that they could ever hope to compete with English manufacturers on their own soil. But the seemingly impossible has become a stern reality. To what extent the passing reality of the present may become the permanent reality of the future, no one can prophesy with confidence. If England had the same cheap transport, and the same perfect economical appliances and systems that are found in the United States, the latter country, despite its rich ores and its cheap fuel, could not compete with us for a moment. What is, then, to be done? We must clearly prepare ourselves to wage the warfare that is imposed upon us by our economic conditions. Let us get well to the front, and keep there. Let us cheapen our ores, reduce the cost of our fuel, improve the character and cheap-

en the cost of our transport, secure a higher range of technical skill, demand more competent and better distributed labor—in short, fight our American rivals with the weapons that they have themselves made use of."

Mr. Jeans, however, is perhaps disposed to attach too little importance to the permanent character of the movement, and unduly magnify the influence of temporary and fortuitous combinations of conditions. To quote his own words: "In other words, we believe that, when the next revival of American industry comes about,—as it is generally expected to do before long,—prices will rise to such a level that we are hardly likely, for a time at least, to hear much more of American competition. Nor is it probable that the extraordinary combination of favorable conditions arranged for by the Carnegie Company can be permanent. It is of such a unique character that it is a greater menace to rival manufacturers in the United States than it is to competitors in Europe. It is almost one firm against the world, and the world, in the long run, is bound to win."

From this view of the case we are bound to dissent, in spite of our profound respect for its distinguished author. We can not believe that the special circumstances and temporary conditions have done anything more than hasten the attainment of a mastery which in itself is ultimately dependent upon deeper-lying, permanent, and intrinsic qualifications. The same preëminent ability which has blotted out differences in labor-cost will win further victories, sufficient to overcome the "difficulty . . of space."

It is such concerns as the Carnegie Steel Company that lead the world. It is our prediction that, when the world has caught up to the present Carnegie standard, the continued and expanding exercise of the "great engineering talent and unique administrative capacity" will have placed the Carnegie Company as far in advance of the pursuing world as they are now in advance of their yet backward competitors. Our reading of history is that the leaders, and not the world, are, "in the long run, bound to win."

Education of German Mechanics.

IN these days of rapid change, when machinery has already supplanted much of the hand labor of former times and is still lessening the amount of labor needed for a given output, the question of the training of mechanics for the positions they are destined to fill in the world of industry has been considered and reconsidered, and methods which until very recent times were unknown have been adopted. One of these is the modern trade school. The system of apprenticeship, though not so far abandoned as many have supposed, is, however, no longer a school to which almost any intelligent boy of good family and habits can apply with almost the certainty of admission. There are yet masters and apprentices, but, in proportion to the numbers employed in the various trades, the proportion of apprentices is relatively much smaller than it used to be. We do not class as apprentices youths employed to operate a single machine and who receive no other instruction than what is necessary in order to do that special work.

Of these there are many more than in the old days, when apprenticeship was a rule of every shop. Pertinent to the consideration of this subject is an article in *Engineering* (Feb. 12) on the "Education of German Mechanics," in which the claim is made that England can learn much from German methods. If this be so, it may be that these methods contain something worth considering by American educators also. German elementary schools are free, and children from the ages of six to fourteen are compelled to attend them. Compulsory attendance has been adopted in some parts of the United States, but, as in some cities where the system is legally required, the school buildings cannot accommodate the existing number of pupils. compulsory attendance has not been uniformly enforced, and its effects have not been fairly demonstrated. The course of study in German elementary schools does not differ materially from that usually taught in American schools to pupils under fourteen years of age. The next grade is the *Mittelschulen*, where French

and mathematics are added to the studies of the elementary grade. Then comes the *Realschulen*, or high school, in which to a more extended course in mathematics the study of English is added. It is thus seen that a youth who has passed through the three grades will know not only his native language, but also something of the two other important languages spoken by civilized races. In the highest grade of the Realschulen, Latin and Greek are included. The children of the poorer classes generally go no further than the Mittelschulen, which they usually leave at the age of fourteen; but in nearly every small town in Germany is an evening school,—continuation school (Handwerker-Fortbildung Schulen),—which boys of the working class are compelled to attend. These schools are mostly free. At some a small fee is charged, in which case it is paid by the masters of working apprentices, or the commercial firms that employ the youths who attend the schools. In these schools mathematics, drawing, English, French, book-keeping, etc., are taught. It is noted that German youths are thus kept under school discipline till they reach an age at which the value of education is generally appreciated. When a student enters a German technical school, he not only must have passed the elementary grammar schools, but also must have been for some time a practical worker in some trade. Attendance upon these schools is not compulsory; the fees are high, the examinations for admission are severe, and, as a consequence, the technical schools are filled with a good class of students. Those who desire an epitome of the German system of education and a comparison of it with that which prevails in England may find both in the very readable article we have named, in which the conclusion is reached that, while the German system has not made German artisans better workmen than the English, it has greatly promoted German trade and commerce "by equipping the manager, the salesman, and the commercial traveller with a stock of knowledge which would put men of the same class in England [perhaps, also, America] to shame."

The Goldfields of Western Australia.

IT is affirmed with great positiveness by Mr. Harry C. Rhys Jones, editor of the Perth *Mining Journal*, that the future of the great colony of Western Australia has been placed beyond the shadow of a doubt, and that it will be a brilliant future. He contributes an article to *The Australian Mining Standard* (Jan. 14), in which he makes this statement, following it up with a glowing description of the country and its resources: "Western Australia is a country of greatness. It is great in extent, great in its known wealth, and great in the vast possibilities which are opening before it, and it threatens to fulfil the declarations of some of the most sanguine of our mining men; who regard it as bound to become, in a short while, the greatest gold field the world has ever known." Language so strong as this, were it not supported, at least partially, by known facts, would sound rather too much like that of a mine boomer whose interest it is to magnify to the utmost the possible and probable resources of a region in which he owns claims; but there are some facts which seem to justify the enthusiasm of Mr. Jones. As compared with the gold fields of Victoria, the gold-bearing areas in western Australia are enormous, extending over hundreds of miles. Judging by the small proportion of disappointments, it is claimed that the country deserves the best that has been said of it. Delay in results in the majority of cases has been caused "by adherence to the rules of scientific mining." Meanwhile the development of the mines has progressed. "The development . . . is not occupying a longer time than would be the case elsewhere if the conditions as to distance and transport were the same." It is asserted that this delay, which has thrown some doubt upon the value of the gold properties will, not much longer continue, and that in less than six months the number of batteries in operation will be quadrupled. The statement made in some quarters that sixty or seventy millions of money have been sunk in the colony is denied, the truth being that probably not more than five millions have been ex-

pended on the gold fields. The scarcity of water for mining purposes even in the driest gold fields is also denied, though this has been widely asserted, to the discredit of the mining districts. "The cost of labor and the strange mining laws" are much more serious disabilities than lack of water. Skilled miners are badly needed. The ores are said to be "so rich that the loss of gold in treating them is not a matter of such importance as it would be to some other countries." On the whole, Mr. Jones's article would not be less impressive, were it a little less enthusiastic There is a sense of extravagance and exaggeration in it, to readers at a distance. which does not strengthen its effect.

A Possible Pacific Cable.

AN interview which a representative of the *Pall Mall Gazette* had recently with Prof. Sylvanus Thompson was made the basis of an article in that paper under the title: "The Pacific Cable Made Possible." The substance of what Prof. Thompson said to the *Pall Mall Gazette*, as reported therein, is reprinted in *The Electrical Review* (Jan. 29) with comments. It outlines a method of overcoming retardation in a cable, which, it is said, has not been previously published, though known to some electricians. Prof. Thompson is reported to have said:

"My cable has two separate conductors, each perfectly insulated and inclosed in the same armor. At intervals of every one hundred or one hundred and fifty miles I introduce stretches of cable with three separate conductors, the third being a wire of high resistance acting simply as a leak. One end of it is connected to the positive conductor, the other to the negative. In this way the static charge on the positive conductor simply neutralizes that on the negative, and, by introducing a sufficient number of such leaks, the retardation can be entirely got rid of." *The Electrical Review* points out the similarity of this principle to that explained in English patent No. 22,304 issued to Prof. Thompson in 1891. This patent describes compensators consisting of wires of high resistance coiled round a core of well-laminated iron joining the two conductors. The patent specification further says that "the coil is covered with insulating material, and its choking or its self-inducing action, if it consist of a sufficient number of turns of fine wire coiled near together, will cause sufficient resistance to prevent all but an insignificant quantity of the working charge to short circuit. In electric cables the induction coils must be further arranged so as not to form unwieldy enlargements of the cable, and are, preferably, long and narrow, and with the axis parallel with that of the cable." The new arrangement described by Prof. Thompson appears to be intended to supersede that described in the patent of 1892, and, in its editorial review of the proposed scheme, *The Electrical Review* admits that it would greatly increase the speed of signaling. It doubts, however, that speeds as great as appear to be expected would be realized. If the "resistance acting simply as a leak" be very high, "the retardation of signals due to static charge" will be considerable, "while the conductor resistance will be double that of a single core." An increase of E. M. F. of the signalling battery will be necessitated, probably developing a weak point near the end where the majority of faults occur. It is claimed that the change would involve no increase in the difficulty of repairing such a cable, but this, it is thought, must "depend on what the so-called stretches of cable with three separate conductors may mean. If several miles in length, and the repair entails cutting into one of these stretches, the whole stretch will probably have to be recovered, in order that the new cable spliced in may give approximately the same leak resistance as the cable requires at this point." Conditions of weather, depth of submergence, and the mechanical condition of the cable might conceivably make additions to the expense of repair that would not be necessary with a cable uniform throughout its length. It is further indicated that the difficulty of localizing faults in so complex a system would be greater than in an ordinary cable. In these and other criticisms any wish to minimize Prof. Thompson's claims for his

"rapid cable" is disavowed, the object being to make as clear a comparison between the old and the proposed new style of cable as present imperfect information of Prof. Thompson's system permits.

Modern Diving Apparatus.

IT is said that there are no unexpired patents on diving apparatus. We are certain that the apparatus now in general use differs in no essential point from that used nearly half a century ago, however much advance in the way of design, workmanship, and material may be shown. But now, as then, this kind of apparatus forms an essential part of an outfit for the recovery of sunken vessels, and of property, from the bottom of the sea. Many interesting details of the construction and use of diving apparatus, as made by an English firm, are presented in an unsigned article in *Transport* (Feb. 12).

The first and paramount consideration in diving apparatus is that of safety. All considerations of convenience in use, storage, or conveyance must be subordinated to this, which is all the more imperative because experienced divers can not always be obtained, and unskilled laborers may be the only help available in some instances. The apparatus, therefore, in its construction, appearance, and record, should be such as will inspire confidence in the minds of those unaccustomed to its use. The English firm alluded to is credited with making an apparatus so simple and easily understood that it may be readily and successfully operated by laboring men who have never before used it. The advances of forty years have been in the direction of simplicity, utility, and durability. The exterior bars which were formerly employed to protect the three glasses of the helmet, and which more or less obstructed vision, are no longer used. The glasses are now made five-eighths of an inch thick, which gives sufficient strength. The front glass of the helmet does not unscrew and screw in as formerly, but opens on a hinged joint, like the scuttle joint of a ship; the diver, on coming to the surface, may open and shut this glass himself, without the risk of dropping it. The helmet, moreover, is supplied with an air valve that may be opened or closed by pressure of the diver's finger, but which, left to itself, closes automatically and remains closed. The valve, under ordinary conditions, is self-acting. It is placed at the side of the helmet, so that the escaping bubbles of the air do not impede vision. The dress is made with sufficient air-capacity to permit time for signaling and drawing up in case of an accidental stoppage of supply. If breakage of the air-supply tube occur, an automatic valve prevents the entrance of water through the tube. The attachment of the weights permits their instant removal when the diver reaches the surface. The air tube itself is a great advance from that once employed. It is composed of three layers of canvas with alternate layers of rubber, and an imbedded wire coil. The pumps employed are an interesting part of the apparatus. They are of three kinds: (1) a three-barrelled single-acting pump is used in pearl, coral, and sponge diving; (2) a two-barrelled double-acting pump is used on occasions where the services of two divers are required below at the same time, as is sometimes the case; (3) a one-barrelled double-acting pump is used in harbor or dock work, in depths up to eighty or ninety feet. The two-barrelled double-acting pump is also used by a single diver for deep-sea diving. For very shallow water, and such work as repairing leaks in ships, the one-barrelled single-acting pump is preferred. A great deal of care is bestowed upon the construction of these as well as all other parts of the air-circulating system of devices. The material of which the dresses are made is a strong twill, first made water-proof and then covered with a layer of pure rubber. Parts liable to more rapid wear than others, as the knees, elbows, etc., may be reinforced. Two thicknesses of the rubber-faced twill are placed with the rubber faces together, and pressed into a single sheet, which is then made up into the dresses. The boots are made of thick, soft calf-skin. From the air supplied to the divers the heat acquired during compression is removed by passage through a copper cooling cistern.

Suction Draft for Marine Boilers.

THE still unsettled state of opinion upon the merits of what are respectively and technically known as forced and suction draft applied to marine boilers was alluded to in the introductory paragraphs of a paper read before the Institution of Engineers and Shipbuilders in Scotland at Glasgow, January 26, by Mr. Matthew Paul. For the information of laymen it may be said that forced draft is brought about by continuously pressing air into a stoke-hold made practically air-tight, except for the draft passages of the furnaces through which the air passes, under the combined action of exterior atmospheric pressure and the mechanical means (usually a fan blower) employed to increase this pressure. Suction draft, on the contrary, aims by mechanical means to increase the flow of air through the furnace by lessening the atmospheric pressure opposing the escape of gases from the uptake and smoke-pipe. In the forced-draft system the cool outside air at its normal density has to be passed along by the action of the fan-blower with a slight increase of density; in the suction draft the gases of combustion, added to the normal volume of air needed for combustion, both expanded by heat, must be handled. To most people, we should think, the forced-draft system would appear the more simple and practicable; notwithstanding this, an argument of considerable force can be made for the suction system, and such an argument is made in the paper referred to for suction draft broadly, and especially for a patented system known as Patterson's, exemplified by experiments made at the works of Messrs. M. Paul & Sons at Dumbarton. First it was maintained by Mr. Paul "that, until the advent of some more commercially successful type of water-tube boiler than has yet been produced," the majority of ships will use mechanical draft. The merits and demerits of the plenum system as related to the life and safety of the boiler, the rates of combustion and evaporation, etc., were briefly mentioned, and were made the subject of comparison with the suction-draft system. Proceeding, the author (as reported in *The Engineer*, Feb. 5) asserted that with forced draft a plenum of three inches was required for a consumption of sixty pounds of coal, per hour, per square foot of grate, and that a consumption of one hundred and eight pounds per square foot of grate, per hour, requires a plenum of nine inches. He asserted it to be "a matter of common knowledge that endless trouble was experienced when an ordinary tubular boiler was worked under forced draught at rates considerably less than those named, and that no attempt to attain them in ordinary sea-going work, over lengthened periods, had yet been successful. Even for short trials, extending over a period of four to eight hours, the boilers had failed repeatedly, with air pressures as low as 2 to 2½ inches, when burning forty-five to fifty pounds of coal per square foot of grate per hour, and the result was that the boilers were increased sufficiently to do the required work at greatly reduced rates" Mr. Paul declared, however, that with suction draft the case was entirely different, and sustained this proposition by reference to satisfactory results of admiralty trials on various ships of the British navy, and to trials of suction draft under what is called the Ellis and Eaves system, made by Messrs. John Brown & Co. at Sheffield, which showed a coal consumption of from forty to sixty pounds, with high efficiency and without any trouble with the furnace bars, even when hot air was supplied beneath them. Mr. Paul described Patterson's system as being Martin's system with a water spray discharged radially from the center of the fan to keep the latter cool and prevent its being injured by the heat of the discharged gases. The author admitted that no satisfactory reason for the greater immunity of boilers with suction draft at an equal rate of fuel consumption, as compared with boilers employing forced draft, has yet been given; but he held that the fact asserted has been amply substantiated by experimental proof. In conclusion, it was maintained that suction draft has distinct advantages over forced draft sufficient to counterbalance increased size and cost.

Car Ferries of the Great Lakes.

AN illustrated description of craft used for transporting cars as variously constructed is an interesting feature of *The Engineer* (London, Feb. 5) which introduces the subject with remarks upon the development and present extent of the system. The boats are "constructed to accommodate a train of cars, and not only to cross the lakes with these in the summer time, but to cross in winter also, when they have to cut their own way through the heavy ice. At first car ferries were used only at few points, where the waters were narrow and . . . bridging was not permitted. But now Lake Michigan is crossed at several places, and one line runs up and down almost the entire length of the lake parallel to the shore. In the latter case the ferry line is much longer than the railway which it serves. When it is remembered that a car ferry has to carry a greater weight of cars than of goods (less than half the cargo pays, and the remainder is dead weight), and that the largest car-ferry boat carries less cargo than would be taken by a smaller and less expensive steamer, it seems that there must be little profit in operating them in places where they are not an absolute necessity; . . . but the car ferry is to all appearance a success. A great deal of money has been invested in these lines by shrewd business men, and several new routes are being considered, so that the car ferry may be said to have passed the experimental stage and become one of the fixed institutions of the lake." The heavy terminal and transfer charges at Chicago are assigned as causes of the growth of the car-ferry system. The boats carry through freights only, and, as the competition on through freight is sharp, it is all the more remarkable that they can do a paying business. As for a time in winter these boats are the only ones navigating the lakes, it may be that they are able to reap an advantage from this circumstance. The beginning of the extension of the car-ferry system to longer distances than the width of the St. Clair and Detroit rivers dates back to "the building of the screw steamer Algomah, in 1881, by the Detroit Dry Dock Company." The boat was built for the Mackinac Transportation Company, which included the Michigan Central, Grand Rapids, and Indiana and South Shore Railways; and the boat "was intended to serve as a connecting link at the Straits of Mackinac." Though not intended to carry cars, and although a failure for winter navigation, this boat demonstrated possibilities which have been realized in subsequent car-ferry boats. The winter navigation of the straits of Mackinac presents extreme difficulties. "The straits form a storm center, and are assaulted in all directions. During the late autumn and early winter the winds make a foot-ball of the rapidly-forming ice. First it is driven in from Lake Michigan, piled up by the surf along the shore, and hurled crashing against the frozen surface of Lake Huron. A change of wind then sets the latter in motion, and the aggressor is forced back, grinding and thundering. The fields of ice collide and break, and all along the meeting edges the smaller pieces are thrown above or forced under the larger ones. With mortar made of seething spray and driving snow the contending fragments are cemented into shapeless masses, which drift against each other, forced this way and that by winds and changing currents, until, in the ever-increasing cold, the passage is finally blocked. The surging mass of hills and valleys, of sharp peaks and deep depressions, becomes quiet and rigid. Day after day the frost makes more firm the bonds by which this irregular surface is held together, and the straits of Mackinac are closed for the winter. At places the ice extends twenty feet above and twenty feet below the usual water surface, and along the shores it is often frozen to the bottom at that depth. Great windrows extend up and down, and across, like miniature mountain ranges, marking the meeting places of fields of ice." The encounter with ice of this character was far too much for the Algomah, although she had the spoon-shaped bow of the more recent car-ferry boats, and was fitted with a powerful engine; but she served to indicate what was still lacking for a successful win-

ter boat,—to wit, greater weight, greater power, and means at the bow for breaking up the windrows and working through the broken ice. The steamer Ignace, designed by Frank E. Kirby, was then built by the Detroit Dry Dock Company for the same owners, and she proved, with her 1,199 tons' measurement, and her heavy propeller at the spoon-shaped bow, operated by an independent engine, to be a grand success. She set the pace for all the boats of this type that have been since constructed. Twelve freight cars can be carried at once on this boat. Subsequently-constructed boats are described, and the routes which have been established are indicated on a chart of the American lake system which accompanies the article.

Insulation Resistance of an Electric Installation.

"WHEN the wiring of a building is completed," says *The Builder* (London, Feb. 20), "it has to pass certain tests before the public supply company will switch on the current. What these tests are can only be vaguely guessed at, as the supply companies talk learnedly in their rules about insulation resistance, and yet, when the consumer tries to find out what electricians mean by the insulation resistance of the wiring of a building, he will find out that it is a vague expression used in different senses by different people. He will probably be told by the consulting electrician that it is a measure of the leakage-flow between the house mains; this is the favorite definition, and, being the simplest, is strongly adhered to by youthful electricians, who think they understand it. How this is measured is clearly described in a well-known work on electrical engineering, published recently and . . . most favorably reviewed by the electrical press: 'All that is necessary,' says this book, 'in testing the insulation of any circuit, is to connect the + and — mains (the insulation between which is to be measured) to the terminals, turn the handle, and the needle at once points to the resistance.'" This quotation is cited to show that it is little to be wondered at that apprentices and wiremen imagine that they know all about so simple a matter. If, however, observation be directed to the inspector of the supply company, he will be found measuring the resistance between each house main and the earth, and, if this does not come up to his views, "he will refuse to switch on the current." Insurance inspectors follow in the same line. "All this time the intelligent consumer is guessing, as he is unable to get any definite information from the secretary of the supply company, and electrical books are hopelessly contradictory. He may think he has found it at last in a new copy of fire-office rules, but, on turning up this, he finds that the insulation resistance has to be measured when all current-consuming and current-producing devices are turned off; and so he gives up the hunt for a definition, and regards electricians as a slippery and unsatisfactory kind of people." The difficulty lies not in the theory of insulation-testing, but in the interpretation of what is meant by it in specifications. It is shown that accurate values of insulation resistance—contrary to the opinion of many—are worth more than the slight extra labor of calculating them according to a method explained in the article by formulæ and diagrams. The numbers ordinarily given may vary widely from the truth. A numerical example used to illustrate this point shows that an error of from two hundred to three hundred per cent. is possible in the ordinary way,—"a matter of great importance when current is taken from a company supplying on the three-wire system"; and the method for easy and accurate testing of insulation resistance by architects and consumers with the assistance of a wireman, as given, will, if studied, clear up the whole matter.

Difficulties Pertaining to Deep Rock Boring.

ON this subject *The Colliery Guardian* has recently given some interesting information, partly abstracted by J. W. Pearse from a paper read by Mr. Charles Zundel before the Société Industrielle de Mulhouse. The difficulties encountered sometimes compel the abandonment of a bor-

ing after a large sum has been expended. Mr. Pearse says that the deepest bore-hole yet put down is at Paruschowitz in Upper Silesia, which work "was undertaken for establishing the government rights to certain coal deposits." The depth of the bore thus made is 2,003.34 meters. The bore passed through eighty-three coal seams, the aggregate thickness of which is 89.5 meters. "Begun with a diameter of 32 centimeters (12 inches), with lining tubes 10 millimeters ($\frac{1}{25}$ inch) thick, the hole was put down to a depth of 70 meters (38 fathoms), from which point to 107 meters (58 fathoms) the diameter was reduced to 27 centimeters (10 inches). At this depth the blue marls were so compact that it was found necessary to resort to diamond boring. Moreover, under the action of the water injected into the hole, the marl swelled, and subjected the lining tubes to such compression that it was found necessary to gradually reduce their diameter." Shifting sand was encountered at a depth of 200 meters (109 fathoms), and much retarded progress. The weight of the boring rods in these deep holes is the greatest difficulty which engineers have to meet in this kind of work. It was this that ended the Paruschowitz boring. Notwithstanding the substitution of steel for iron, the total weight reached 13,707 tons. A breakage occurred; the lower part of the rods became so jammed in a yet untubed part of the boring that it was impossible to raise them. The cost of this boring is stated to have been 37.60 marks per meter. The temperature at the total depth reached was found to be 69.3° Cent.

Water Gages for High-Pressure Steam Boilers.

IN a former number of this magazine, while discussing the practical limitations of steam pressure for power purposes, the frequent breaking of the glass tubes of water gages at high pressures and temperatures was named as one of the minor difficulties which, up to a recent period, has formed one of these limitations. The employment of talc or mica gages has in some measure removed this disability. It is scarcely necessary to specify the inconveniences or (especially with rapid steaming boilers having a comparatively small water capacity) even the dangers that may follow the breaking of glass gages. An article on this subject by Mr. T. C. Billetop in *The Colliery Guardian* enumerates some of the ways by which it has been sought to remove or lessen this difficulty, the talc gage being the latest device for the purpose. It seems, however, that the glass gage is not yet by any means shelved, the talc gage being held in reserve for use in case of the breakage of the glass gage. The risks in the use of the glass gages have been lessened by the following devices. "Cocks have been made with automatically-closing ball-valves, which, however, have never become favorites with engineers, who wisely keep clear of complications in such important fittings. Hand gears have been commonly introduced for shutting off. Guards of plate glass or of wire have been fitted round the gage. Special makes of glasses have been tried. Glasses have been annealed or coated internally with different kinds of varnish, but, with it all, the same uncertainty exists. One glass might last a week or a month, another one minute. The causes of these failures cannot always be defined; for, while bad workmanship, clumsy or careless handling, or unusually trying conditions can easily be traced, it is very often impossible to state reasons why the glasses break. Various theories have been advanced, such as the special condition of new glass tubes, the cutting action of the steam at the top of the glass, damage due to condensation, etc." Want of homogeneity in the glass, even in glass of the same make, is also a probable cause. It is certain that under high temperatures and pressures glass will succumb to shocks and strains which it will endure at less pressures and temperatures. To obviate sudden changes various protective devices have been resorted to. Some steam-tight glass guards, so arranged that, in case of the breakage of the glass, the guards form a substitute for it, have not proved very effective; the sudden breakage of the inner tube is often sufficient to cause the breakage of the thicker

guard. Talc is a material which, while transparent, is also strong enough to withstand the pressure; it is, moreover, not liable to crack under changes of temperature. But this substance, answering excellently well at first, rapidly loses its transparency when in use, and after a time becomes useless from this cause. This opacity takes place near the water line. It appears that, while it will remain transparent when brought into contact with dry steam only, the heated water, on the contrary, produces some molecular effect upon mica which renders it thus opaque. It has, therefore, become the practice to fit boilers carrying high pressures with two gages, one of talc and one of glass. The glass gage is the one regularly employed. In case of the breakage of the glass gage, the mica gage can be immediately put into action, and used till the glass gage can be effectively repaired. Employed in this way, the talc gage can be made to last for a considerable period. It is now proposed to surround the glass tube by a gun-metal case fitted with mica plates into which steam enters at full boiler pressure, and out of which the small amount of water condensed in the jacket constantly drains. The glass tube thus would be kept at the same interior and exterior pressure and temperature,—a condition which greatly conduces to its durability. The mica will probably last much longer used in this way, but it is not quite evident that it can escape deterioration, as more or less water of condensation must come in contact with it. The free loss of heat from the exterior of this compound metal and mica case cannot be presented, unless covering it by glass is practicable. Even this would not entirely prevent escape of heat. If heat escape, condensation must ensue, and the condition of dryness in the steam essential to the preservation of the mica will more or less fail to be established.

The Brazil State Railways.

ANENT the proposed leasing of these railways to foreign capitalists *Transport* (Feb. 12) enters a protest against the brevity of the time (three months) allowed for the receipt of tenders. The condition of the roads is very bad, and, before making contracts or executing leases for property certain to require large outlays before it can be made remunerative (possibly to remain unremunerative for years), the capitalists who might invest in these properties will very carefully investigate the conditions and count the cost of putting the roads in working order. *Transport* thinks twelve months none too long a time for such examination and estimate, and predicts that capitalists are not likely to fall over each other in their haste to get control of the Brazilian railroads under the terms fixed upon by the Brazilian government, which has made a miserable failure in its attempted management of the railway lines. "It may be that the government will elect to accept the offer of any syndicate of speculators who intend to tranfer the property to a subsequently-organized syndicate. . . The government may, in that case, be able to realize on the lease sooner, but the syndicate will find it impossible to place the property with experienced railway men until a thorough examination and report have been made by trustworthy and competent men. The condition to which the between four and five thousand miles of railway which it is now proposed to lease have been brought by the grossest mismanagement is exemplified by the Central railway, which, it is estimated, would require an outlay by the lessees of £10,000,000 sterling. Such an amount as this will not be forthcoming in haste.

The term of the leases is sixty years, at the end of which the roads are to be returned in good condition and without indemnification."

THE FRENCH AND GERMAN PRESS

Protestant Church Architecture.

THE February issue of the *Oesterr. Monatscher. f. d. Oeffent. Baudienst* contains a long illustrated article by Herr F. Meldahl, in discussion of the question whether there has yet been evolved a definite style of Protestant church architecture.

Starting with the distinction between the Protestant and Catholic services, the former being based upon the hearing of a discourse and the latter upon the offering of the mass, he proceeds to illustrate the development of church buildings since the time of the reformation. Many of the earlier Protestant places of worship in German were chapels in the palaces of Protestant princes, and, in accordance with the decadent taste of the seventeenth century, the gaudy rococo school is very much in evidence in the illustrations of such chapels. The auditorium arrangement of seats, which has of late years come into vogue in some Protestant churches in this country, appeared in many of the Lutheran churches of the seventeenth century, although the cruciform ground plan, with the pulpit at the intersection of the nave and transepts, was a favorite form. The fact that the Calvinist form of Protestantism in France and Switzerland spread chiefly among the poorer classes until more recent times accounts for the meager development of church architecture in those countries. English church architecture is shown only by one example of Wren, S. Stephen's Walbrook, and one by Hawksmoor, S. Mary Woolnoth, so that what is probably one of the most influential forces in the development of a Protestant style of architecture is but slightly considered.

The article, however, is of interest and value in so far as it relates to the development of the subject in Germany during the seventeenth and eighteenth centuries.

Pier Foundations on Slopes.

IN the construction of the approaches to the new Kornhaus bridge at Berne, to which reference has already been made in these pages, some special details of the pier foundations are of sufficient importance to warrant special mention, and Herr Simon, whose plans for this portion of the work were adopted, contributes to the *Schweizerische Bauzeitung* (Feb. 6) an illustrated account of the method of procedure. The bridge is to cross the Aar at a high level, spanning the stream with a single great arch, while the nature of the banks requires that the piers must be built in the steep slope of the bank. This means that they must be carried down through more than fifty feet of packed earth, and then through about twenty-five feet of clayey loam, to a bed of gravel. The character of the work makes it most important that there shall be no movement to either of the piers, since the presence of the wedge of loam under the main bank of earth might cause the whole hillside to slip, were it once set in motion. Bearing this point in mind, it was decided to carry down foundations of such weight and stability as to render this action impossible.

Each pier foundation consists of two elliptical brick caissons, so to speak, the method of construction adopted being somewhat like that used for sinking well linings in India. Instead, however, of building upon the caisson from above, and permitting it to sink by its weight as the earth was excavated beneath, the brickwork was laid in sections from beneath, a shaft being sunk in the center, and then portions of the space under the masonry were successively dug out and replaced with brickwork, until the whole periphery had been completed. In this way the brick shafts have been carried down to the gravel-bed practically as a whole, without previously requiring the dangerous operation of excavating in the earth and clay slope.

The dimensions of each shaft are 20 feet by 11, and there are two shafts to each pier; the completed shafts are filled with concrete, and form each a solid mass of masonry.

It is apparent that this method requires that time must be given for the mortar of one course to harden before under-cutting for the next, and, in fact, forty-eight hours were found sufficient for this purpose, spaces of three to four feet being left unsupported underneath, while the brick-

work was being filled in. The maximum settling observed was in the east shaft, and was only about one inch, which shows that the method was most carefully executed.

A sheet of details accompanies the article, which is well worthy of perusal by engineers in this country.

Boiler Incrustations.

IN connection with the thorough treatment of the subject of corrosion and scale from boiler-waters in Mr. Cary's articles appearing in THE ENGINEERING MAGAZINE for March and April, it is interesting to note some phases of European experience and practice, as reviewed by M. Dibos, in *La Revue Technique* (Jan. 25). After referring to the experiments of Hirsch as to the increase in temperature of the plates caused by deposits of scale of various thicknesses, he discusses the danger of explosion due to the formation of scale, distinguishing between the powdery deposit of carbonate of lime and the hard, crystalline aggregation of sulphate of lime.

According to analyses, which are given in full, more than 75 per cent. of scale deposited from river-water is carbonate of lime, and only about 3 per cent. sulphate, while, for brackish water, the proportions of carbonate and sulphate are nearly equal, being about 40 per cent. each. For seawater the other extreme is reached; there is more than 85 per cent. of sulphate and less than 1 per cent. of carbonate. The quantity of hydrate of magnesia in none of these cases rises above 4 per cent., but its presence causes the incrustations to become harder and more resistant than they otherwise would be.

M. Dibos describes a remarkable case of strong corrosive action upon the metal underneath the coating of scale, recently investigated at Brest in the boilers of the Oriolle. According to Bertin, this action is caused by a reaction between the chlorid of sodium and silicic hydrate, producing silicate of soda and hydrochloric acid, and also by a reaction between the chlorid of sodium and the silicate of magnesia, giving a silicate of soda and chlorid of magnesium, decomposed in turn by the heat.

Referring to the innumerable remedies which have been proposed, that of heating the feed-water to 150° C. (282° F.) and separating the precipitated sulphate of lime is mentioned, as well as Dulac's system of precipitating the impurities chemically and separating the solid matter before the water is permitted to enter the boiler. Various materials that may be introduced into the boiler to separate the scale-forming constituents are named; the evils of this method are found in the unequal manner in which such reagents act. The portion of scale in immediate contact with the plates is not acted upon, and the softening of a portion only renders frequent cleaning necessary to prevent the loosened scale from collecting elsewhere.

The too common practice of testing a boiler by hydrostatic pressure and assuming it safe without a thorough interior examination is condemned, and a careful inspection every ten or twelve months is recommended.

In concluding, M. Dibos refers to the so-called "antitartrate" solution of Lieut. Bretel, which appears to be an alkaline tannate that has been used with success in the boilers of the *Messageries maritimes*, as well as in vessels belonging to the well-known firm of Cockerill, of Seraing.

The Creep of Rails.

A VALUABLE paper upon the above subject was presented recently before the railway section of the Austrian Society of Engineers, by Inspector von Engerth, and is now printed in full, with diagrams, in the *Zeitschr. d. Oesterr. Ing. u. Arch. Vereines* for January 22 and 29. The fact that rails do creep has long been observed, but this shifting of position appears to be a final resultant of so many different causes that its full investigation is voluminous. Inspector v. Engerth has collected data from a number of the continental railways, and from these he studies the problem. Especially is he indebted to M. Collard of the Paris-Lyons-Mediterranée railway, and to the report of Herr Ast upon Austrian railways.

In most of the roads investigated, the creep was in the direction of the travel of

trains, and also down the grades, as might be expected. The greatest creep observed was that on the Kaiser Ferdinands-Nordbahn, where the maximum was 260 millimeters in one year, but this was exceptional, as on the same road the total creep for seven years was 420 millimeters. The creep, however, takes place on straight, level sections of road, and, furthermore, is not alike for both rails, the left rail almost invariably showing the greater creep.

Careful measurements were made upon about 500 miles of the Austro-Hungarian State railways, of which more than 300 miles are double-track, and data were obtained upon the following points: nature of ballasting, relative level of rails, width of embankments, character of rail-fastenings, length of time in which no creep occurred, and other special points that presented themselves.

M. Collard, in his investigations, found that in double-track roads the creep was in the direction of train motion, and explains this action as follows:

When the engine wheels approach the end of a rail, the weight of the engine causes the rail to spring down a little lower than the end of the next rail, which has as yet none of the weight upon it. This causes the wheel to strike a blow upon the end of the rail which is being approached, and the horizontal component of this blow acts to drive the rail along in the direction of the motion of the engine. The greater creep of the left rail he explains by the fact that on the Paris-Lyons-Mediterranée road, on which the trains keep to the left, the outer rail, being further away from the center of the road-bed, is not so well supported as the inner rail, and hence suffers greater deflection. For single-track sections, the creep appears to be in the direction of the swiftest trains or the heaviest loads, thus bearing out the same theory.

The investigations in Austria, however, did not altogether support this view. Herr Spitz, who assisted in making the examinations, found that the greater creep of the left rail also appeared on the Hungarian roads, on which the trains keep to the right, the left rail being in the middle portion of the road-bed, showing that some other cause must be found to explain the inequality. Local conditions, such as difference in ramming the ballast, unequal depth, etc., were found to cause unequal creep, and in some instances the creep was less down steep grades than on portions more nearly level.

Herr Spitz, to whom the credit for the second portion of the paper is due, thinks that the true cause of the unequal creep of the rails is the action of the forces in the engines; he contributes an elaborate discussion of the successive impulses tending to produce blows upon the rails. Taking each side separately, he plotted the successive phases, and then, combining them into one diagram, showed the resultant to be in accordance with the observed facts.

It would be interesting to apply the same analysis to the observations made in this country, and thus obtain a confirmation or refutation of this result.

The Development of Telephony.

THE issues of the *Elektrotechnische Zeitschrift* for February 4 and 11 contain a paper read before the Electrotechnic Society of Berlin by Herr West, upon the future development of the telephone, referring principally to Germany, although many of his points are of value and interest elsewhere. After referring to the importance of increased facilities for communication, the author takes up the subject of long-distance telephony, and shows how its use might be greatly extended by a different system of operation. He suggests that the whole country should be divided into sections, each with its own central station or exchange in its largest city, and that then a system of long-distance connections should be arranged between these centers, so that any subscriber in any section could be placed in connection directly with the exchange of any other section and call up any subscriber therein. In this connection he refers to the very great development of telephony in Sweden and in Switzerland, there being in the former country one instrument to every 133 inhabitants in 1894, and in the latter one telephone to every 154 inhabit-

ants, later figures for 1895 bringing Switzerland up to one instrument for every 132 persons.

Great stress is laid upon the necessity of doing away with all ground connections and the introduction of metallic circuits. In connection with the subject of underground conduits, illustrations are given of the clay conduits used in Christiana and Copenhagen, these being shaped like iron channel beams, built up horizontally upon each other.

In the discussion which followed the interesting point was brought out that those countries in which the telephone is most widely used are those in which postal facilities are least developed, and the inference cannot be resisted that possibly a wider extension of telephone facilities might cause a corresponding diminution in postal receipts, and possibly modify altogether existing postal systems, especially if recording-telephony, which was also discussed, be brought to a practical state.

The Action of Stones in Streams.

HERR FERDINAND WANG, professor at the Agricultural High School in Vienna, and royal forest commissioner, has contributed to the *Oesterr. Monatschr. f. d. Oeffentlichen Baudienst* for February a valuable article upon the laws which govern the relations of the water in swift streams to the rocks and stones carried along by the current. This matter is a very important one in the mountain torrents of Switzerland and the Tirol, and, as a mathematical investigation of some of the problems connected with geological erosion, the paper referred to is of significance.

The author considers successively the influence of the presence of loose stones upon the velocity of the water; the impact of the water against the stones, and the resistance of the latter; the limits of the velocity and carrying-power of the water; and the laws which govern erosion, and consequent modification of the profile of the stream.

Although it is not to be expected that rigid laws can be deduced governing a problem in which there are so many variables, yet there are certain general considerations which are of importance.

According to the formula deduced for the velocity of clean water carrying loose stones, it appears that, when the volume of water and stones are equal, the mean velocity is reduced to less than one-half its normal value. The velocity, however, is modified, not only by the mass, but also by the shape of the stones and the manner of their motion, whether singly or in groups. Formulas are given for the impact and resistance of the stones, and from these it is shown that the density of water has a very great influence upon its action in this respect, water saturated with mud, for instance, being much more powerful in its action than pure water.

Water may become saturated, so to speak, with stones and detritus, this saturation depending upon its velocity, much in the same manner as its carrying-power for mud. From this portion of his investigation Herr Wang deduces formulas and laws for the eroding and carrying-power of streams which are of importance in connection with the question of the correction and control of torrents.

Variations in the width of the stream change its velocity, and the material eroded from one place is deposited in another only to change the velocity again and cause new modifications; but for this portion of the subject we must refer the reader to the formulas of the original. An interesting example of the action of the water upon solid bodies is given. During the construction of the Birsig viaduct at Basle a scaffold was overturned, and, among other things, a pillow block, or journal bearing, was lost in the river, and could not be found. Several years afterward it was discovered in excavating for some foundations, more than a thousand feet farther down the stream, buried under ten feet of pebbles!

Improvements in Gas Engines.

AT a recent meeting of the society of German engineers, Herr Petréano gave an account of his improvements in gas engines, by means of which a practically instantaneous explosion is obtained. An

illustrated report is given in the *Zeitschrift des Vereines deutscher Ingenieure* (Feb. 6), from which the following is abstracted.

It has been demonstrated experimentally that the explosion in gas engines of the Otto type is not instantaneous, but continues during the greater portion of the stroke, and that, in fact, unburned gas is discharged with the exhaust. This results in a reduced initial pressure and consequent reduced efficiency, as well as an unnecessary heating of the cylinder, requiring excessive cooling. The coefficients of diffusion of various gases have been determined by Guglielmo, Obermayer, Stefan, Loschmidt, and Waiz, and their results confirmed by Herr Petréano's own experiments, and these show, for example, that 1 liter of marsh gas requires 6 seconds to become fully diffused in 1 liter of air, and that 1 liter of gas compressed with 5 liters of air requires 10 to 12 seconds for diffusion. When, therefore, the time of a single revolution of a gas engine is considered, it will be seen that the mixture cannot become sufficiently intimate to permit proper instaneous explosion.

The apparatus of Herr Petréano provides for the mixture of the air and gas before they enter the cylinder, and consists of a cylindrical chamber through which passes longitudinally a central tube; through this tube the exhaust gases pass, thus heating it to a high temperature. The tube is covered with a wicking of asbestos fiber, and a series of diaphragms are fitted in the annular space between the outside of the central tube and the inside o the chamber. The incoming gas and air pass through this mixing and heating chamber, and are thus thoroughly diffused before they enter the cylinder for compression, and the result, as shown by indicator diagrams, is a greatly-increased rapidity of combustion, and an increase, not only in the initial, but also in the mean effective, pressure.

According to experiments made at the Technical High School at Charlottenburg, it is also possible to avoid altogether the use of circulating water in the jacket, it being only necessary to keep the jacket filled with water, and supply the loss by evaporation. After a ten hours' run under these conditions, the cylinder remained clean, the temperature of the water in the jacket not having exceeded 80° C. (176° F.) The pressure shown by indicator cards for the explosion with the usual construction is only about 2.7 times the pressure of compression, while with the new arrangement the pressure of explosion is shown to be 3.7 times the pressure of compression.

Photographing Rail Deflections.

IN an article about the technical applications of photography by Herr Wilhelm Müller, in the *Zeitschr. des Oesterr. Ing. u. Arch. Vereines* for February 5, an arrangement is shown for enabling the deflections of rails, bridges, etc., under moving loads, to be photographically recorded. Briefly, the apparatus consists of a camera of which the plate-holder is fitted to slide across the back by clockwork, so that a series of successive images may be taken upon one and the same plate at uniform intervals of time. The rail or beam to be observed has attached to it a brilliantly-polished bead, which is photographed as a point of light, and the successive images of this point show the deflections. A second lens causes the images of a similar stationary point to be photographed upon the same plate in a line just below, thus furnishing a base line for comparison. The images are so close together that they practically form a continuous line, the deflection images giving an irregular curve showing the movements of the rail, while the spacing of the points upon the base line are clearly enough defined to enable the intervals of time to be noted.

It is, of course, essential that such an apparatus should be mounted upon a very solid foundation, as the least vibration of the camera would be fatal to the accuracy of the record; and the objective used must have great light-gathering power, owing to the feebleness of the illumination. The apparatus as installed in the Nordbahnhofe in Vienna is fixed upon a masonry pier, is fitted with a Zeiss anastigmat objective, and has given excellent results in practice.

Central Condensing Apparatus.

IN large establishments, where there are many engines, pumps, compressors, and other steam motors, the idea of installing one central condensing plant has been advocated, all the engines exhausting into one condenser with its independent air and water pumps.

An illustrated description of such a central condensation plant is given by Herr Carl Habermann, in the *Zeitschrift des Oesterr. Ing. u. Arch. Vereines* (January 22), and the details are of sufficient interest to warrant presentation here.

The particular plant under consideration is that of the "Ewald" mine, at Herten, where there is a total of over 2,300 h. p. of steam motors, including the large winding engine, air compressors, pumps, etc. The condenser here used is arranged in a separate building from the main engine room, and consists of a system of brass tubes connected by return bends, forming a large box-coil standing in a room. These tubes are cooled by water dripping upon them from above, while a current of air enters from below and passes out above into a sheet-iron stack, thus carrying away the vapor from the room and increasing the rapidity of the evaporation from the outside of the tubes. The water which drips from the tubes falls upon a series of inclined surfaces exposed to the incoming air, and is thus cooled enough to be used again and again, being drawn from the collecting chamber below by a rotary pump and delivered above to the condenser.

The exhaust pipes from the various steam engines all deliver into one large shell, which is connected to the condenser, and in this shell a vacuum is maintained of about 85 per cent. of the atmospheric pressure, or, with the barometer at 30", about 12.5 pounds.

The air pump is operated by an independent engine, which also drives the circulating pump, and the speed is controlled by a regulator operated by the vacuum, thus keeping the latter quite uniform.

This installation has been in operation for about a year, and has thus far shown an economy of about seventeen per cent. in fuel, enabling two boilers to be dispensed with, besides furnishing pure feed-water and avoiding the formation of scale in the boilers.

The particular apparatus described in the above case is that of Messrs. Balcke & Co., of Bochum; but there are several other makers in Germany, and a list of eleven installations is given, aggregating 32,000 h. p., of which 5,500 h. p. is at Krupp's works at Essen, and 4,000 at the Mannesmann works at Komotau.

The Mining of the Rarer Earths.

THE invention of the Welsbach incandescent light has stimulated a search for the materials of which the mantle is composed, and *La Revue Technique* calls attention to the limited supply of some of the materials. At present nearly all the supply of thorite and orangite comes from Norway, and, as a consequence, a mining center has sprung up there. The most active element in the production of the incandescent mantle is the rare metal, thorium, which is found in thorite and orangite to the extent of 50 to 70 per cent., and, as these minerals are not found to any extent elsewhere, Norway has the monopoly. Thorium is also found in monazite, although in a much smaller proportion, and, as this mineral is found not only in Norway, but also in Siberia, Brazil, and North and South Carolina, it forms a secondary source of supply. Since monazite contains the phosphates of cerium, lanthanum, and didymium, as well as thorium, it has been sought to utilize these remaining elements as by-products, in order to reduce the net cost of the thorium.

Up to the present time only the cerium has been used, in the form of oxid, as a coloring material for glass, producing a fine yellow tint. Attempts to use it for coloring ceramics and textile products have not been so successful, but experiments are being continued in the laboratory of the technical high school at Charlottenburg.

So far no practical applications of the didymium and lanthanum have been made, and this field is yet open for the investigation of the technical chemist.

Rapid Transit in Vienna.

THE issues of the *Zeitschrift d. Oesterr. Ing. u. Arch. Vereines* for January 1 and 8 contain a very full account of the new Vienna local railway system from the pen of its director, Herr von Klammstein, with many illustrations of the work.

For a number of years Vienna, like most other large cities, has been seeking rapid transit, but the execution of the work was delayed from various causes, until the present plans were authorized by the enactments of 1892. The system is divided into a main belt line of about 8¼ miles in length, encircling the built-up portion of the city, together with local lines connecting this belt line with the various railways approaching the city. A careful study was made of the London underground railway, as well as of the elevated roads in Liverpool, New York, and Chicago, and, as a result, the Vienna road is a combination of both underground and elevated systems. As the road is intended to be operated in connection with the main railways' systems for suburban travel and for summer excursions, the connections with the terminal stations are made at the station level, after which the belt line climbs first to an elevation above the street level, and subsequently passes into a cutting and runs underground, the elevated portion, however, being the most extensive.

The overhead work is much more substantial than that to which New Yorkers are accustomed, much of the road running upon a handsome masonry structure, while wide streets are spanned by single arches of steel or masonry, of artistic design and ornamental construction.

The road is planned at present to be operated by steam, although the subject of converting it ultimately to an electric system has been taken into consideration in its construction. Two forms of cars are used, one being the orthodox European compartment "carriage," and the other the American corridor pattern. The whole structure is an important attempt at the solution of the vexed question of local rapid transit, and the successful operation of the Vienna system will be watched with much interest by other great cities.

Cantilever Constructions.

THE issue of *Glaser's Annalen* for February 1 contains a valuable paper read before the German Railway Society by Professor Reuleaux upon the subject of cantilever constructions in bridges and in buildings. The paper is mainly descriptive in character, and contains numerous illustrations of cantilever bridges, among which may be mentioned those at Frankfurt a.M. at Loschwitz, and especially the new Mirabeau bridge over the Seine at Paris. The latter is a remarkable example of that skilful combination of excellent structural design with artistic effect which the French know so well how to produce. In the hands of American and English engineers the cantilever has been carried to a high degree of structural excellence, but it is almost the unanimous opinion that a cantilever is an uglyaffair, detracting greatly from whatever beauty the surroundings may possess. The Mirabeau bridge, on the contrary, is artistic in appearance, and, in the graceful curves of its main span of 325 feet, it recalls the smaller arches of Ammanati's famous Arno bridge, claimed to be the most beautiful in the world.

Professor Reuleaux also gives illustrations of the Forth bridge, the Verrugas viaduct, the Poughkeepsie bridge, and others well known on this side of the Atlantic, and concludes his paper with a description of some of the details of construction of tall buildings in New York.

Utilization of Power at the Iron Gates.

THE completion of the canalization of the Danube at the Iron Gates, of which an account was given in these columns last month, has given rise to various schemes for the utilization of the power of the water at the various dams. The control of the power is in the hands of the three kingdoms bordering on the river, and already in Hungary a cement and barrel factory, as well as several woodworking establishments, are operated by the power of the river. At present only about 1,000 h. p. are taken off, but it is estimated that about 30,000 h. p. are available, most of which will be transmitted electrically to various points for use.

The Leipzig Memorial.

THE artistic results of competition are not usually very gratifying from an esthetic point of view, possibly from the fact that inspiration cannot be manufactured to order, and doubtless also because the best architects are generally unwilling to enter competitions. This may be the reason why the designs submitted in the competition for the Leipzig memorial are so commonplace. Good half-tone reproductions of the drawings are published in the issues of the *Deutsche Bauzeitung* for January 16, 20, and 23. The location of the proposed monument is excellent, being on a moderate eminence, to be approached by a new avenue giving a fine opportunity for proper display, while surely historic inspiration should not be lacking for a memorial to be placed in the midst of the field of the "battle of the nations" in the year of the "deliverance."

The design which carried off the first prize, and which bore the name "Walküre," resembles an Aztec pyramid flanked by the apse of a Romanesque basilica, upon which is perched one of the battle maidens holding aloft her spear. The second prize was awarded to Herr Rieth, of Berlin; while possessing some effective points, it is but a reproduction of the various details in the battle monuments in other German cities, consisting, as it does, of a colossal seated figure of the orthodox "Germania" with arm aloft and sword in lap. The other designs, seven in all, are disappointing, and it cannot be doubted that more satisfactory results would have been obtained, had the commission been given to some already eminent sculptor, rather than submitted to a competition.

Placed beside such a noble memorial as Thorwaldsen's lion at Lucerne, the monuments proposed for Leipzig hardly seem worthy of more than passing notice as examples of the result of art competitions.

Water Gas in Vienna.

THE water-gas question, which has been pretty well settled on this side of the Atlantic, is agitating Vienna, and an article by Dr. Hugo Strache, in the *Wiener Bauindustrie-Zeitung*, discusses the matter at length. After alluding to the extensive use in the United States of water gas enriched with petroleum, he admits that the higher price of petroleum has been an obstacle to its economical use in Europe. The introduction of incandescent gas burners, however, does away with the necessity of enrichment, and under these new conditions the superior economy of water gas over coal gas is manifest.

The question of the poisonous nature of water gas Dr. Strache does not think of sufficient importance to forbid its use, and he refers to the various methods of insuring freedom from fatal consequences, such as self-closing burners which require to be warmed by the match before the gas can escape, and which close by cooling if the gas should be blown out accidentally. He also suggests the use of spongy platinum to make a self-lighting burner, so that escaping gas would relight the flame and prevent accidents.

In addition to the demand for lighting, the supply of gas for motors is urged, and altogether a very strong case for water gas is made.

The Calibration of Current Meters.

THE February issue of the *Oesterr. Monatschrift d. Öffentlichen Baudienst* contains an interesting account of the apparatus used by the Austrian Hydrographic Bureau for calibrating current meters of the Woltmann-Mill type, and determining constants for their rating. The tank is nearly 400 feet long and nearly 6 feet deep, entirely closed in a shed. On each side of the canal is a rail, so that a car carried on the rails runs directly over the canal. This car is propelled by electricity, and its speed can be regulated from about 100 feet per minute up to 1,000 feet. On the car is placed the recording apparatus, consisting of a chronograph, a speed-recorder, and a distance-recorder, all making electric records of the various data.

The current meter makes an electric contact for every fifty revolutions, while the chronograph marks seconds, and the distance is recorded for every ten meters; and, as all these appear side by side on the

same strip of paper, the relations which the revolutions of the meter bear to the elements of time and distance may be fully investigated.

The article referred to gives an example of the calibration of a meter made by the well-known firm of Hipp, of Neuchatel, exhibiting very fully the practical working of the apparatus.

The same article gives a description of Schaffler's "Limnigraph,"—an apparatus for recording the level of water in reservoirs, lakes, and other bodies. This consists of an ingenious combination of a counterbalanced float and a revolving drum, a graphical record being traced, showing the level of the water at any moment.

Electrical Progress in Hungary.

THE Hungarian Millennial has done much to open the eyes of the rest of the world as to the great and rapid progress which that enterprising nation has made in all matters technical, and a report by Dr. Moritz v. Hoor in the *Zeitschrift des Vereines deutscher Ingenieure* (Jan. 30) upon some of the electro-technical features of the exposition shows that Hungary is not behind in applied electricity. Notwithstanding all that we have heard about the success of the underground trolley in Budapest, the trolley tramcars shown at the exposition have the familiar overhead pole, and are in all respects the same as those used here.

Some neat little electric mine locomotives of 4½ tons' weight are also illustrated, these having been used at the exposition on a railway in the grounds, drawing four cars for twenty passengers each.

A handy little portable drilling machine by Ganz & Co. is exhibited. It is suspended to a crane hook, the transmission being through a short shaft with double universal joints. Such drills are extensively used in the machine shops of Hungary. A novel application also was shown in the connection of an electric motor to operate the cable of a captive military balloon, the motor being controlled from the car of the balloon, and also regulated automatically by the speed of the ascent.

Continental Locomotives.

DURING 1896 three exhibitions were held in Europe, at which extensive displays of rolling-stock were made, and in a previous review we have noticed some of the features of the railway exhibits at the Hungarian Millennial.

Herr von Littrow, the chief engineer of the Austrian State railways, contributes to the issue of the *Zeitschrift des Oesterr. Ing. u. Arch. Vereines* (Feb. 5) a review of the engines exhibited at Berlin, Budapest, and Nuremberg, covering details of the twenty-four locomotives shown; and his article is a very complete account of the approved practice of central Europe at the present time. Nine of the engines were compound in principle, and of these four were built with four cylinders, some of them decidedly peculiar in arrangement.

Outside valve gears were used in all cases, the well-known Walschaert form being the favorite, but the Allan and the Stephenson link motions also appeared, while in one engine—a combination rack locomotive on the Abt system—the Joy gear was shown, accompanied, however, by the explanation that it was employed because there was no possible room for eccentrics.

Among the novelties a heavy compound consolidation engine of 65 tons by Krauss, of Munich, was shown, constructed with the high-pressure cylinder sunk into the lid of the low-pressure, and a single-trunk piston operating in both. A single valve admits steam to both cylinders, the exhaust from the high-pressure passing through a passage in the valve to the other end of the low-pressure cylinder, as used by du Bousquet nearly ten years ago, in France. In this engine, however, the low-pressure cylinder is of the annular type, and there is a pair of such cylinders on either side, this being one of the four-cylinder locomotives above referred to.

Another engine of interest, also by Krauss, has a pair of single drivers 1,860 millimeters in diameter, with a pair of auxiliary drivers 1 meter in diameter to assist in starting. This latter pair of wheels has its own engines complete, and is ar-

ranged with a pressure cylinder over the axle, so that the adhesion can be augmented by the amount of the full boiler pressure, thus practically giving what a bicyclist would call a "low gear" for starting, and at the same time dispensing with the objectionable parallel rod. This auxiliary engine is also used to assist in climbing steep grades, or it may be thrown out of service by relieving the pressure on the journals, when the driving-wheels are lifted out of contact with the rails.

A general sheet of illustrations exhibits in skeleton the different types of engines and the leading dimensions are tabulated in a comprehensive manner.

Railways in Hungary.

THE rapid development of Hungary during the past twenty years has almost equalled that of some of our western States, as is evinced by the fact that the population of Budapest has increased from about 300,000 to 600,000 in seventeen years, and the recent celebration, intended to commemorate the thousandth anniversary of the appearance of Arpád and his followers in Europe, was really rather a demonstration of the growth of Hungary in the past generation.

Nothing has been more marked in Hungary than the development of its railway system, and, from a contribution by Edmund Kelényi in *Zeitschr. d. Ver. Deutcher Ing.* for January 9, the following account is condensed.

Apart from the mechanical details of railway operation, the most remarkable showing is that of the success of the "zone" system for railway tariffs.

The great reduction in rates stimulated travel to such an extent that, from 5,047,500 passengers carried by the Hungarian State railways in 1889, the number rose to 15,690,600 in the next year. With this increase in patronage the extension of the lines has increased, the mileage growing 57 per cent. and the number of passengers 108 per cent. between 1890 and 1894. The development of general industry is also well shown by the increase in goods traffic. Formerly about the only merchandise consisted in grain, and the business fluctuated every year with the harvests. In 1867 the total traffic was 3,881,500 metric tons, carried 581,753,400 ton-kilometers (about 361,000,000 ton-miles), while in 1894 it had risen to 27,589,300 metric tons and 3,653,374,500 ton-kilometers (about 2,236,000,000 ton-miles). An interesting feature in this connection also is the fact that, instead of being a source of loss, as they were before the introduction of the zone system, the Hungarian State railways showed a profit in 1894 of 4.92 per cent. on the capital.

Steel rails were introduced in 1870, and in 1895 82 per cent. of the rails in use were of steel; iron sleepers are extensively used.

The principal feature at the millennial exhibition, however, was locomotives, and Herr Kelényi devotes much space to illustrations and descriptions of them. Some of these are only of historical interest, but full detail drawings are given of a 54-ton compound express locomotive. This engine is of the four-cylinder tandem type, with Walschaert valve gear, swivel truck, four driving-wheels 2 meters in diameter, and boiler of the regular American type, intended to carry 185 pounds' pressure. The engine looks much more like an American locomotive than those usually seen on the continent, and is credited with a speed of 90 kilometers an hour.

The locomotives are built at the government shops at Budapest, the works having a capacity of one hundred and ninety engines a year, and the various types shown give evidence that the establishment is up to date.

Electric Traction in Versailles.

THE trolley still continues to make its inroads into France, and that in places where it might least be expected. The hitherto quiet and almost sleepy town of Versailles has been awakened, and the completion of a belt system of electric tramways has made travel easy and rapid. It is interesting to note that the American system of the General Electric Company, having overhead wires, is used, and, altogether, the former retreat of the Grand Monarque has become considerably Americanized.

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Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6*s*. London
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
Kansas University Quarterly. *qr.* $2. Lawrence, Kan.
La Nature. *w.* 24.50 francs. Paris.
La Révue Technique. *b-m.* 28 francs. Paris.
L'Eclairage Electrique. 60 fr. Paris.
Le Génie Civil. *w.* 45 fr. Paris.
L'Electricien. *w.* 25 fr. Paris.
Le Moniteur des Architectes. *m.* 33 francs. Paris.
Le Moniteur Industriel. *w.* 40 francs. Paris.
Locomotive Engineering. *m.* $2. New York.
Machinery *m.* $1. New York.
Machinery. *m.* 9*s*. London.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7*s*. 6*d*. London.
Master Steam Fitter. *m.* $1. Chicago.
Mechanical World. *w.* 8*s*. 8*d*. London
McClure's Magazine. *m.* $1. New York.
Metal Worker. *w.* $2. New York.
Mining and Sci. Press. *w.* $3. San Francisco.
Mining Industry and Review. *w.* $2. Denver.
Mining Journal, The. *w.* £1. 8*s*. London.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. 3 marks. Stuttgart.
Municipal Engineering. *m.* $2. Indianapolis.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York
Oesterreichische Monatsschrift für den Oeffentlichen Baudienst. *m.* 14 marks. Vienna.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6*s*. 6*d*. London
Popular Science Monthly. *m.* $5. New York
Power. *m.* $1. New York.
Practical Engineer. *w.* 10*s*. London.
Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of Civ. Engs. *yr.* 50 cts. La Fayette, Ind.
Progressive Age. *s-m.* $3. New York.
Railroad Car Journal. *m.* $1 New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Magazine. *m.* $2. New York.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7*s*. London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5*s*. London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10*s*. London.
School of Mines Quarterly. $2. New York.
Schweitzerisches Bauwesen. *w.* 20 marks. Zurich.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York
Scientific Am. Supplement. *w.* $5. New York
Scientific Machinist. *s-m.* $1.50. Cleveland, O
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stahl und Eisen. *s-m.* 20 marks. Dusseldorf.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Assn. Civil Engs. of Cornell Univ. Ithaca.
Trans. Am. Ins. Electrical Eng. *m.* $5. N Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York.
Transport. *w.* £1. 5*s*. London.
Western Electrician. *w.* $3. Chicago.
Western Railway Club, Pro. Chicago.
Wiener Bauindustrie Zeitung. *w.* 27 marks. Vienna.
Wisconsin Engineer. *qr.* $1.50. Madison, Wis.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.
Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines. *w.* 63 marks. Vienna.
Zeitschrift des Vereines Deutscher Ingenieure. *w.* 32 marks. Berlin.
Zeitschrift für Elektrochemie. *s-m.* 16 marks. Halle, a. S.
Zeitschrift für Elektrotechnik. *s-m.* 16 marks. Halle a. S.
Zeitschrift für Instrumentenkunde. *m.* 20 marks. Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

BRICK.

Use and Advantage of Hollow Brick. J. M. Mamer. Sets forth many advantages, and discusses means of introducing; gives results of tests and brief discussion. 2,500 w. Brick—Feb., 1897. No. 11,043. 15 cts.

BRISTOL.

The Architecture of Bristol, Eng. Illustrated description. 6,500 w. Builder—Jan. 30, 1897. No. 10,979. 30 cts.

CATHEDRAL.

Ely Cathedral. A paper prepared by the late Sir Gilbert Scott, in which the origin of the different parts of the building is described and their architectural value determined. Ill. 2,500 w. Arch, Lond.—Jan. 29, 1897. Serial. 1st part. No. 10,977. 30 cts.

CHURCHES.

Protestant Church Buildings. (Der Protestantische Kirchenbau.) An illustrated historical description of the development of protestant church buildings, mainly in Germany. 8,000 w. Oesterr. Monatschr. f. d. Oeffent. Baudienst—Feb., 1897. No. 11,442. 30 cts.

CLAY.

Clay in Architecture. Henry R. Griffen. Discusses the changes within the past few years in the use of clay in architectural work; and the tendency of the times. Read at Nat. Brick Mfrs.' Assn. and followed by discussion. 5,400 w. Brick—Feb., 1897. No. 11,045. 15 cts.

DECORATION.

The Decorations in the New Congressional Library. William A. Coffin. Illustrated description of the interior decorations. 7,500 w. Century Mag—March, 1897. No. 11,231. 45 cts.

DESIGN.

Principles of Design. W. A. Langton. Read at the annual convention of the Ontario Assn. of Archts. A study of rules and principles that may be a guide in matters of taste. Followed by discussion. 4,800 w. Can Archt—Feb., 1897. No. 11,143. 30 cts.

FIREPROOF Construction.

Materials and Methods in Fireproof Construction. W. M. Scanlan. The writer names the forms of construction and the materials that seem to him the best. Of materials, porous tiling is considered the best, and the beam floor construction. 4,300 w. Eng Mag—March, 1897. No. 11,336. 30 cts.

FOUNDATIONS.

Field Engineering Abroad. Condensed selections from papers by Sir Guilford Molesworth, with illustrations prepared from copies of original photographs. Part first treats of heavy foundations in loose and alluvial soil. 2,400 w. Eng Rec—Feb. 20, 1897. Serial. 1st part. No. 11,148. 15 cts.

GYMNASIUM.

Gymnasium at Podgórze, near Cracow. (Turnhalle des Turnvereines "Sokol" in Podgórze vei Krakau.) Plate and brief description of a fine gymnasium hall, also arranged for theatrical performances, &c. 300 w. 1 plate. Oesterr. Monatschr. f. d. Oeffent. Baudienst—Feb., 1897. No. 11,441. 30 cts.

HOSPITAL.

Hospital for Chest Diseases at Davos. (Die Basler Heilstätte für Brustkranke in Davos.) Plans, elevation and description of special cantonal hospital of 70 beds, near Basle, Switzerland. 3,000 w. Schweizerische Bauzeitung—Jan. 30, 1897. No. 11,446. 15 cts.

LABORERS' Houses.

The Housing of the Laboring Classes Problem. Percy Boulnois. Some comments on the latest developments in England. 1,500 w. San Rec—Feb. 19, 1897. No. 11,309. 30 cts.

LIBRARY.

The Nation's Library. A. R. Spofford. Illustrated description of the new building and special features of the Congressional Library, as given by the Librarian. 4,500 w. Century Mag—March, 1897. No. 11,230. 45 cts.

TEMPLE.

The Temple of the Malatesta at Rimini. Description taken from an article by Miss Robinson in the English Illustrated Magazine. 1,800 w. Am Arch—Feb. 20, 1897. No. 11,191. 15 cts.

HEATING AND VENTILATION.

HOSPITAL.

Ventilation of a Detroit Hospital. Illustrated description of a heating and ventilating plant designed and installed by the Am. Blower Co. of Detroit. 1,300 w. Eng Rec—Feb. 20, 1897. No. 11,152. 15 cts.

HOT Water.

Heating Buildings by Hot Water. F. Dye. It is proposed to give a complete account of the not water engineer's work in heating buildings, and this will include a full description of the newest English and American methods and systems. Part first explains action of heat and cause of circulating movement. 2,000 w. Plumb & Dec—Feb. 1, 1897. No. 11,089. 30 cts.

STEAM Heating.

Circulation of Steam for Heating Purposes at or Below the Pressure of the Atmosphere. Reginald Pelham Bolton. A study of the difficulties and limitations, with description of improved apparatus. Followed by discussion. 7,000 w. Heat & Ven—Feb. 15, 1897. No. 11,133. 15 cts.

VENTILATION.

Relative Efficiency of Ventilation by a Chimney and by a Fan. R. C. Carpenter. Determined by circulation and by reference to experiments made relating to effi-

ciency of fans and engines. 2,800 w. Heat & Ven—Feb. 15, 1897. No. 11,134. 15 cts.

LANDSCAPE GARDENING.

GARDEN.

The Garden in Relation to the House. H. E. Milner. Read at meeting of Royal Inst. of Brit. Archts. Discusses the treatment to be adopted in laying out grounds, particularly in their relation to the house. Discussion follows. 3,500 w. Builder—Feb. 20, 1897. No. 11,279. 30 cts.

PLUMBING AND GASFITTING.

PIPE.

Lead Pipe vs. Iron Pipe. William Eccles. Compares the several advantages of lead and galvanized iron pipe when used for water supply and vent pipes. 1,000 w. Dom Engng—Feb., 1897. No. 11,106. 30 cts.

PLUMBING.

Law and Bad Plumbing. Some account of the work done by Mr. H. A. Desper, of Worcester, Mass., to show the effect of bad plumbing on health and so influence legislation to provide for the examination of plumbers, and the control of this work. Ill. 6,400 w. Met Work—Feb. 20, 1897. No. 11,142. 15 cts.

Plumbing in the St. Paul Building, New York. Part first contains general description and arrangement, diagram of risers, pipe systems, materials, waste, vent and supply lines, and pressure test. 2,400 w. Eng Rec—Feb. 13, 1897. No. 11,020. 15 cts.

MISCELLANY.

ARCHITECTURAL History.

An Unwritten Chapter of English Architectural History. A. S. Flower. Results of independent research into the history and characteristics of the Mediaeval architecture of England. 5,500 w. Arch, Lond—Feb. 12, 1897. No. 11,193. 30 cts.

ARCHITECTURE.

Is Architecture a Living Art? Peter B. Wight. First of a series of papers discussing two questions—"Is Architecture a Living Art?" and "Can Architecture Again Become a Living Art?" read before the Illinois Chapter of the Amer. Inst. of Archs. 6,500 w. In Arch—Feb., 1897. Serial. 1st part. No. 11,098. $1.00.

DE TRESGUERRAS.

A Great Mexican Architect. Sylvester Baxter. Francisco Eduardo de Tresguerras and his work. Part first states the architectural conditions of Mexico in this architect's time. 1,800 w. Am Arch—Feb. 13, 1897. Serial. 1st part. No. 11,050. 15 cts.

MASONS.

Criticism on "Code of Practice of the Chicago Masons' and Builders' Association." Dankmar Adler. An open letter to Chicago mason builders with a copy of code. 3,300 w. In Arch—Feb., 1897. No. 11,097. $1.00.

MONASTERIES.

The Meteora Monasteries in Thessaly. Herman Hirsch. Illustrated description of the strange location and the peculiarities of the landscape. From Ueber Land and Meer. 1,000 w. Sci Am Sup—Feb. 27, 1897. No. 11,212. 15 cts.

PADUA.

Italian Cities; Padua. H. Mereu. Interesting information concerning the architecture and arts of this city. 1,800 w. Am Arch—Feb. 27, 1897. No. 11,246. 15 cts.

SCULPTURE.

Sculptors and Architecture. Brief review of the work of sculptors as connected with architecture, explaining the connection of Phidias with the Parthenon, the work of Brunelleschi in constructing the dome of Santa Maria del Fiore, in Florence, &c. 2,800 w. Arch, Lond—Feb. 12, 1897. No. 11,192. 30 cts.

The Sculptor's Architecture of the Renaissance. Alfred Gilbert. Read at meeting of Roy. Inst. of Brit. Archt's. A short but interesting paper on the work of the sculptor-architect; followed by discussion. 1,600 w. Arch, Lond—Feb. 5, 1897. No. 11,070. 30 cts.

STAINED Glass.

Stained Glass as a Modern Art. Reviews a recent book, "Stained Glass as an Art," by Henry Holiday. The changes being wrought by the study of the figure as the leading element in stained glass design. 3,000 w. Builder—Feb. 13, 1897. No. 11,185. 30 cts.

CIVIL ENGINEERING.

BRIDGES.

ACCIDENTS.

Bridge Accidents in the United States and Canada in 1896. Charles F. Stowell. Tabular statements are presented, with explanatory remarks. 1,400 w. Eng News—Feb. 11, 1897. No. 11,018. 15 cts.

BRIDGES.

See same title under Railroad Affairs, Maintenance of Way and Structures.

CANTILEVER.

Cantilevers in Bridge and Building Construction. (Freiträger im Brücken-und Hochbau.) A paper read before the German Railway Society by Prof. Reuleaux, with many illustrations of European and American practice. 8,000 w. Glaser's Annalen—Feb. 1, 1897. No. 11,418. 30 cts.

DRAWBRIDGE.

See Railroad Affairs, Way and Structures.

FOUNDATIONS.

Pier Foundations of the Kornhaus Bridge at Bern. (Kornhausbrücke in Bern Fundierung des Schüttehaldepfeilers.) An account of the sinking of the foundations for the great arch over the Aar. The foundations had to be carried

through sloping banks of earth and loam to deep gravel below. 2,500 w. 1 plate. Schweizerische Banzeitung—Feb. 6, 1897. No. 11,447. 15 cts.

PLATE Girder.

Best Method of Erecting Plate Girder Bridges. Discussion of committee report at convention of the Assn. of Ry. Supts. of Bridges and Buildings. Ill. 1,800 w. Pro of Assn of Ry Supts—Oct., 1896. No. 11,057. 45 cts.

A New Formula for So Locating Two Plate Girders Relative to a Curve as to Bring Equal Loads to Each. Henry Szlapka. Applies, strictly speaking, to plate girders without a cover plate only, but is a very close approximation also in case of girders with plates. 250 w. Eng News—March 4, 1897. No. 11,356. 15 cts.

RHINE.

Proposed Bridge Over the Rhine at Worms. (Der Wettbewerb um den Entwurf einer festen Strassenbrücke über den Rhein bei Worms.) A description, with details, of a three-span stiffened suspension truss bridge, with spans of 350 feet. Two articles. 12,000 w. Zeitschr. d. Vereines Deutscher Ing—Jan. 16 and 23, 1897. No. 11,401. 45 cts.

STEEL.

Steel Road Bridge, 150 Feet Clear Span. Illustration of the general design and some details of a steel road bridge lately supplied to the Travancore Government. 450 w. Ind Engng—Jan. 9, 1897. No. 11,032. 45 cts.

STONE.

The Historical Development of Stone Bridges. George F. Swain. Lecture delivered before the Assn. of Engng. Soc. Traces the history from the earliest times and the progress by different nations. Illustrated. 5,700 w. Stone—Feb., 1897. No. 11,138. 30 cts.

TIMBER.

Strength of Various Kinds of Timber Used in Trestles and Bridges. Especially with Reference to Southern Yellow Pine, White Pine, Fir and Oak. Discussion of committee report at the convention of the Assn. of Ry. Supts. of Bridges and Buildings. 1,600 w. Pro of Assn. of Ry Supts—Oct., 1896. No. 11,056. 45 cts.

VIADUCT Disaster.

See same subject under Railroad Affairs, Way and Structures.

CANALS, RIVERS AND HARBORS.

CANALS.

New York's Canals. Campbell W. Adams. An exhaustive but not too technical discussion of the work under the nine-million dollar canal improvement bill. States opposition to a ship canal and benefits to follow present improvement of free canals. Also editorial. 6,000 w. Sea—March 4, 1897. No. 11,245. 15 cts.

DAM.

Bear-Trap Dam — Chicago Drainage Canal. Illustrated detailed description. 1,300 w. R R Gaz—Feb. 12, 1897. No. 11,013. 15 cts.

DISMAL SWAMP.

The Dismal Swamp Canal. J. Clinton Ranson. Account of a new traffic route between the North and South. 2,200 w. Tradesman—March 1, 1897. No. 11,305. 15 cts.

FLOODS.

The Seasons and Causes of Western River Floods. James L. Greenleaf. Showing the conditions that govern the rise and fall of Western rivers. Ill. 4,500 w. Eng Mag—March, 1897. No. 11,340. 30 cts.

NEW YORK.

New York Harbor. Some account of the marked features of the harbor, the amount of trade and the great number of vessels, both for marine and inland navigation, which visit the wharves. 1,500 w. Sea—Feb. 18, 1897. No. 11,141. 15 cts.

RIVER FLUSHING.

See "Tunnel," under Municipal Engng., Sewerage.

WATERWAYS.

The Report of the United States Deep Waterways Commission. Extracts from the report bearing on the feasibility of the canal as a commercial enterprise, and some conclusions as to the merits of proposed routes. Also editorial comment. 12,000 w. Eng News—Feb. 11, 1897. No. 11,017. 15 cts.

HYDRAULICS.

DEBRIS.

The Laws of the Motion of Debris (Die Gesetze der Bewegung des Geschiebes.) A valuable discussion of the motion of stones and debris in mountain torrents, with investigation as to the erosion and modification of channel profiles. 7,500 w. Oesterr. Monatschr. f. d. Oeffent. Baudienst. Feb., 1897. No. 11,443. 30 cts.

HYDROGRAPHY.

Hydrographic Service of Austria in 1896. (Der hydrographische Dienst Oesterreichs im Jahre 1896.) Report of the Austrian hydrographic bureau, with illustrated description of tank for testing current meters. 4 plates. 4,000 w. Oesterr. Monatschr. f. d. Oeffent. Baudienst—Feb., 1897. No. 11,440. 30 cts.

RAINFALL.

Cloudburst in Southern Dalmatia, Nov. 8 and 9, 1896. (Der Wolkenbruch am 8 und 9 November, 1896, in Süd. Dalmatien.) Report of the hydrographic bureau upon the meteorological conditions accompanying the hurricane and extraordinary rainfall of above date, 234.4 mm.=9.2 ins. of rain, fell in 24 hours. 2,000 w. Oesterr. Monatschr. f. d. Oeffent. Baudienst—Feb., 1897. No. 11,444. 30 cts.

IRRIGATION.

CANAL.

The Nira Irrigation Canal. Describes one of the large works designed for famine-relief purposes. Maps and sections.

2,000 w. Eng, Lond—Feb. 5, 1897. Serial. 1st part. No. 11,029. 30 cts.

PUBLIC Lands.

The Arid Public Lands, Their Reclamation, Management and Disposal. Elwood Mead. The inefficiency of the existing public land system is shown and the evils resulting from it. Discussion follows. 17,500 w. Trans Am Soc of Irr Eng—Jan., 1897. No. 11,054. 45 cts.

MISCELLANY.

CEMENT.

The Annual Meeting of the Association of German Portland Cement Manufacturers. S. B. Newburry. An account of the annual meeting, with reports of committees, abstracts of papers, &c. 5,000 w. Eng News—Feb. 25, 1897. No. 11,238. 15 cts.

The Behavior of Portland Cement in Sea Water. Dr. William Michael's. From proceedings of the Inst. of Civ. Engs. Vol. CVII. Describes researches of the writer. 2,500 w. Eng Rec—Feb. 20, 1897. No. 11,149. 15 cts.

CONCRETE.

Notes on Portland Cement, Concrete. Andreas Lundteigen. Tests and favorable results from the admixture of silicious material. 1,600 w. Pro Am Soc of Civ Engs—Feb., 1897. No. 11,234. 45 cts.

DEFLECTIONS.

Technical Applications of Photography. (Ueber die Anwendung der Photographie für technische Zwecke.) Special appliance for photographing rail and bridge deflections; also photogrammetric apparatus, for photographic surveying. 1,200 w. Zeitschr d Oesterr Ing u Arch-Vereines—Feb. 5, 1897. No. 11,427. 15 cts.

EDUCATION.

Engineering Education. (Zur Frage der Ingeineurerziehung. Prof. O. Mohr.) A discussion of the present methods of engineering education in Germany, suggesting simplification of the existing courses in order to provide time and opportunity for study of new subjects. 3,000 w. Zeitchr d Vereines Deutcher Ingenieure—Jan. 23, 1897. No. 11,403. 30 cts.

FILL.

The Compressibility of Salt Marsh Under the Weight of Earth Fill. Eugene R. Smith. Tables of information obtained by the writer from investigations of reclaimed marsh land on the north shore of Great South Bay, at Islip, N. Y. The work is briefly described. 1,100 w. Pro Am Soc of Civ Engs—Feb., 1897. No. 11,233. 45 cts.

JAPAN.

Engineering Works in Japan During 1896. C. Kardono. Does not encourage American contractors to come to Japan on account of their ignorance of customs and usages of the country in contract works. Information of recent improvements. 800 w. Eng News—Feb. 25, 1897. No. 11,239. 15 cts.

SURVEYING.

Experiences with the Contract System of U. S. Land Surveys in Florida. J. Francis Le Baron. Shows the folly of letting to the lowest bidder a class of work that requires ability. Also editorial. 3,500 w. Eng News—Feb. 18, 1897. No. 11,129. 15 cts.

TUNNEL.

The Design and Construction of a Small Steel Cylindrical Tunnel. See same title under Municipal Engng—Sewerage.

The Roof Shield in the Boston Subway. Describes a novel development of shield tunneling as used in the Boston subway. It consists in cutting the shield in two and using the upper half only. Ill. 2,000 w. R R Gaz—Feb. 12, 1897. No. 11,012. 15 cts.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

BICYCLE.

American Bicycles in Germany. A statement of the methods necessary to secure a share of the trade. 1,200 w. Cons Repts—Feb., 1897. No. 11,041. 45 cts.

Bicycle Trade in Italy. Discusses the prospect for opening a large export trade in American bicycles. Thinks it favorable and gives reasons. 1,500 w. Cons Repts—March, 1897. No. 11,227. 45 cts.

ELECTRICAL Exports.

American Exportation of Electrical Machinery. Georg Kirkegaard. Calling attention to the market of Northern Europe, and Americans' chances to compete. 600 w. Elec Wld—Feb. 13, 1897. No. 11,036. 15 cts.

GOLD Traffic.

See same title under Mining and Metallurgy, Gold and Silver.

GREAT BRITAIN.

British and Foreign Trade. Extract from memorandum issued by Sir Courteray Boyle, relating to the trade of the United Kingdom in recent years compared with France, Germany and the United States. Deals with population, industry and commerce. 4,000 w. Col Guard—Feb. 5, 1897. No. 11,074. 30 cts.

Foreign Competition and English Railway Rates. Abstract of lecture by Mr. Balfour Browne. The serious and increasing competition is discssed and suggestions made for remedying the trouble, especially the methods for exporting, regulation of railway rates, &c. 3,500 w. Ir & Coal Trds Rev—Feb. 12, 1897. No. 11,201. 30 cts.

Is England's Industrial Supremacy a Myth? S. N. D. North. An analysis of the industrial development of England and Germany, showing that nations may flourish under a protective system and

decline under free trade. 5,000 w. Forum—March, 1897. No. 11,286. 30 cts.

IRON Trade.

An International Comparison of Iron and Steel Exports in 1896. Compares the exports from Great Britain with Germany, France and Belgium. Shows that Great Britain has succeeded in improving her position. 2,200 w. Ir & Coal Trds Rev—Feb. 19, 1897. No. 11,281. 30 cts.

JAPAN.

Foreign Trade of Japan. A somewhat detailed examination of its exports and imports, with information relating to cotton spinning and weaving, the supply of raw cotton, manufacture of silk and the rug and matting industries. 18,000 w. Nat Assn of Mfrs—Circ. No. 11. No. 11,175. 45 cts.

Japanese Industries. Information regarding the manufacture of matches, paper, lacquer, porcelain and glassware; also products of forest, farm and sea. 9,500 w. Nat Assn of Mfrs—Circ. No. 11. No. 11,177. 45 cts.

The Commerce and Industries of Japan. Includes a general account of the location of the principal industries, industrial ambitions, population, occupations and wages, with introductory remarks. 7,200 w. Nat Assn of Mfrs—Circ. No. 11. No. 11,172. 45 cts.

JOINT Stock Companies.

The Economics of Joint Stock Companies and the Laws Relating to Their Incorporation. J. Bawden. Examines the system now in general use in Ontario and British Columbia for converting into cash the stock of mining companies, calling attention to amendments required. Discussion follows. 9,500 w. Can Min Rev—Feb., 1897. No. 11,328. 30 cts.

KOREA.

Trade Prospects in Korea. Editorial discussion of the conditions of the country since the war as gleaned from various reports, and the movements which promise to advance trade interests in the future. 1,500 w. Engng—Feb. 12, 1897. No. 11,164. 30 cts.

MANUFACTURERS.

Annual Report of the President of the National Association of Manufacturers. Records the progress of the work of the Association. Reports on So. Amer. commission, sample warehouses, trade with Mexico, Japan, China, discusses the Nicaragua Canal, merchant marine, tariff, &c., &c. 12,500 w. Circular of Information—No. 13. Feb. 1, 1897. No. 11,072. 45 cts.

PIG-IRON Trade.

See same title under Mining and Metallurgy—Iron and Steel.

RUSSIA.

Agricultural Machinery in Russia. A statement of the conditions existing in Russia in reference to agriculture and manufactures, and the opportunities for trade in machinery and implements. 1,300 w. Bd of Trd Jour—Feb., 1897. No. 11,293. 30 cts.

TARIFF.

Customs Tariff and Regulations of the German Southwest African Protectorate. Translation of a customs ordinance with executive regulations, and the customs tariff. 3,800 w. Bd of Trd Jour—Feb., 1897. No. 11,296. 30 cts.

New Customs Tariff of Brazil. A statement of the duties liable under the new customs tariff in cotton, wool, flax and jute, and manufactures thereof. 4,500 w. Bd of Trd Jour—March, 1897. No. 11,297. 30 cts.

Tariff Changes and Customs Regulations. Denmark, Netherlands, Germany, France, Madagascar, Portugal, Spain, Egypt, United States, Costa Rica, Ecuador, Argentina, Chile, British India, Grenada and Tasmania. 3,000 w. Bd of Trd Jour—March, 1897. No. 11,298. 30 cts.

UNITED STATES.

The Concentration of Industry and Machinery in the United States. E. Levasseur. Extract from one of the chapters of a work now in press. Directs attention to the part which the spirit of invention and the characteristics of the laboring classes have taken in this development, and considers the attitude of the laboring classes and of the entrepreneur to the problems which this transformation has called forth. 6,000 w. An Am Acad—March, 1897. No. 11,290. $1.00.

CURRENCY AND FINANCE.

BIMETALLISM.

Obstacles to International Bimetallism—I. Can the Gresham Law be Circumvented? Jerome Dowd. II. Some of the Obstacles to International Bimetallism. Mark B. Dunnell. Two articles strongly favoring monometallism. 4,000 w. Bankers' Mag., N. Y.—Feb., 1897. No. 11,108. 45 cts.

CURRENCY.

Further Considerations of Our Currency Problem—Charles T. Haviland. Considers the paper currency and the gold reserve, the Baltimore currency plan, menace of the legal tender notes, prejudice against the National banks, suggestions for a bank currency, taking the government out of the banking business, and what to do with the silver in the Treasury. 5,000 w. Bankers' Mag., N. Y.—Feb., 1897. No. 11,109. 45 cts.

The Quantity Theory—W. A. Scott. An inquiry into the nature and soundness of this theory. The writer thinks that the level prices and the volume of currency are not determined by the same influences. 6,000 w. An Am. Acad.—March, 1897. No. 11,292. $1.00.

FINANCIAL Legislation.

The Financial Measures Needful to Industrial Stability. James H. Eckels.

Favoring abandonment of note-issuing by the government, and modification of the Sub-Treasury system. 2,600 w. Eng. Mag.—March, 1897. No. 11,335. 30 cts.

FREE Coinage.

Silver Free Coinage and the Legal Tender Decisions. C. G. Tiedeman. Calls attention to the difficulties which would have been encountered in securing from the Supreme Court of the United States a declaration that a silver free coinage bill was unconstitutional. 4,500 w. An Am. Acad.—March, 1897. No. 11,291. $1.00.

LABOR.

CO-OPERATION.

Co-operative Contracts and Capital. Editorial discussion of the limitation of co-operation. 2,500 w. Engng—Feb. 12, 1897. No. 11,162. 30 cts.

DWELLINGS.

See title LABORERS HOUSES, under Architecture, Construction and Design.

EDUCATION.

The Education of German Mechanics. Editorial discussion of the lessons to be learned from German methods, and particularly from her educational system. 2,500 w. Engng—Feb. 12, 1897. No. 11,163. 30 cts.

JAPAN.

Some Considerations Affecting Japanese Labor. Statements regarding the expense of living, wages and habits of life. 3,300 w. Nat Assn of Mfrs—Circ. No. 11. No. 11,178. 45 cts.

PRISON Labor.

Prison Labor. Carroll D. Wright. The various sides of the question are presented and the economic side shown to be of little importance. By giving more attention to the ethical side of the question, the writer thinks the best results will be reached. 3,800 w. N Am Rev—March, 1897. No. 11,282. 45 cts.

WAGES.

Wages in New York's Industries. Average wages in thirty industries as reported by the State Bureau of Statistics of Labor. 800 w. Bradstreet's—Feb. 13, 1897. No. 11,009. 15 cts.

MISCELLANY.

COMBINATIONS.

The Good and the Evil of Industrial Combination. Arthur Twining Hadley. Discusses the benefits and defects from various points of view. 6,000 w. Atlantic M—March, 1897. No. 11,171. 45 cts.

CORPORATIONS.

How to Reform Business Corporations. V. H. Lockwood. The necessity of corporations and the methods of preventing the mismanagement are discussed, with the difficult problems that must be solved. 3,500 w. N Am Rev—March, 1897. No. 11,283. 45 cts.

EXPOSITION.

The Paris Exposition of 1900. A report on the coming international exposition, setting forth its general scope and character, its organization, the financial arrangements, the special features, systems of classification and awards adopted, and regulations affecting foreign exhibitors. 6,500 w. Cons Repts—Feb., 1897. No. 10,974. 45 cts.

GREAT BRITAIN.

Progress of the British Colonial Empire During the Sixty Years of Her Majesty's Reign. Charles W. Dilke. Historical survey of the colonies, followed by discussion. 14,000 w. Jour Soc of Arts—Feb. 12, 1897. No. 11,179. 30 cts.

HARD Times.

What Are Normal Times? E. V. Smalley. Discusses what normal times really are, and shows that conditions have changed and that it is useless to look for a restoration of the abnormal conditions existing between 1880 and 1890. 2,000 w. Forum—March, 1897. No. 11,285. 30 cts.

IRELAND.

Recommendations of the Recess Committee for the Development of Ireland's Agricultural and Industrial Resources. Horace Plunkett. States the circumstances under which the Recess Committee was formed, its work, effect of past action, Ireland's resources, &c., with discussion. 12,000 w. Jour Soc of Arts—Feb. 5, 1897. No. 11,048. 30 cts.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY AND METALLURGY.

ALUMINUM.

The Bradley Aluminum Patents. The invention relates to a process of effecting by the electric current the separation of aluminum from its ores or compounds. Specifications and drawings. 1,500 w. Eng & Min Jour—Feb. 27, 1897. No. 11,248. 15 cts.

CARBORUNDUM.

Details of the Carborundum Furnace and Its Operation. Illustrated detailed description. 1,200 w. Elec Eng—Feb. 24, 1897. No. 11,205. 15 cts.

LIGHTING.

ALTERNATING Current Arc.

Luminous Efficiency of the Alternating Current Arc. A. E. Blondel, assisted by E. Jigouzo. Extract from a forthcoming publication upon the efficiency of the electric arc. Sets forth the first results of a study of the alternating current arc. 1,800 w. Elec Wld—Feb. 13, 1897. Serial. 1st part. No. 11,038. 15 cts.

CONDUITS.

Interior Conduits. Replies received from manufacturers and engineers in response to a circular letter inquiring for opinions in regard to methods permitting the greatest economy consistent with safety. 3,700

w. Elec Wld—Feb. 27, 1897. No. 11,259. 15 cts.

GAS and Electricity.

See Electricity, under Municipal Engineering, Gas.

INCANDESCENT.

Conductivity of Incandescent Carbon Filaments and the Space Surrounding Them. Abstract of paper by John W. Howell, presented at meeting of Am. Inst. of Elec. Eng., with editorial comment. The paper considers the reversal in the temperature coefficient, and demonstrates that such reversal becomes more prominent as the treatment of the filament is increased. 3,000 w. Elec Wld—Feb. 20, 1897. No. 11,187. 15 cts.

Incandescent Lamps. (Zur Glühlampenfrage.) A discussion of the tests of incandescent lamps at Hanover, from the lamp manufacturer's standpoint. 3,000 w. Elektrotechnische Zeitschr—Jan. 28, 1897. No. 11,433. 15 cts.

INSULATION.

The Insulation Resistance of an Electric Installation. Explains the theory of insulation testing. 2,000 w. Builder—Feb. 20, 1897. No. 11,278. 30 cts.

MUNICIPAL Plants.

The Agitation for Municipal Plants. A series of short articles giving a collection of data bearing on municipal electric light plants, with editorial. 11,500 w. Elec Eng—Feb. 17, 1897. No. 11,096. 15 cts.

Report to the Special Investigating Committee on Commercial Electric Lighting, South Norwalk, Conn. A. E. Winchester. A favorable report of the success of various municipal plants. 10,500 w. Elec Eng—Feb. 17, 1897. No. 11,095. 15 cts.

PROJECTORS.

Projectors. W. H. Pretty. Part first discusses reflectors and lamps. A study of the optical arrangements suited for the purpose of transmitting the light given out by the electrical lamp. 1,400 w. Elect'n—Feb. 19, 1897. Serial. 1st part. No. 11,273. 30 cts.

PUBLIC Buildings.

The Lighting of Public Buildings. H. W. Handcock and A. H. Dykes. Calling attention to the need of installing electric lighting in a more permanent way, if it is to give satisfaction. 2,000 w. Elec Eng, Lond—Feb. 19, 1897. No. 11,311. 30 cts.

SAFETY Devices.

Safety Devices for Electrical Circuits. W. M. Stine. Gives attention to certain mechanical safety devices, as well as fuse wires, and gives results of investigations. 3,300 w. W Elec—Feb. 20, 1897. No. 11,145. 15 cts.

SEARCH Light.

Latest Types of General Electric Search Lights. Illustrated description. 900 w. Elec Eng—Feb. 24, 1897. No. 11,207. 15 cts.

TESTING.

Faults and How to Find Them. Attention is confined to the faults that are common to the various classes of arc lamps. 2,200 w. Am Elect'n—Feb., 1897. No. 11,225. 15 cts.

VOLTAGE.

Electricity Supply at 230 Volts. Alfred H. Gibbings. Presents the results of a wholesale changes of pressure at Bradford The subject is considered in detail. Part first dealing with house terminal fuse boxes, meters, wirings and fittings. 2,400 w. Elec—Feb. 17, 1897. No. 11,099. 15 cts.

WIRING.

Inconsistencies in Electric Wiring. Harry N. Gardner. Calls attention to little inconsistencies which detract from the advantages which would result from carefully installed electric systems and urges the giving of electrical work to only reliable contractors. 2,000 w. Elec Eng—Feb. 24, 1897. No. 11,206. 15 cts.

Interior Wiring. George T. Hanchett. Calls attention to the important details wherein alternate current wiring differs from direct current wiring. 1,800 w. Am Elect'n—Feb., 1897. No. 11,224. 15 cts.

POWER.

AIR and Electricity.

See Electric Power under Mechanical Engineering, Compressed Air.

ALTERNATING Current.

Method of Determining the Number of Alterations (Ueber eine Methode zur Bestimmung der Wechselzahl oscillirender Ströme.) A mathematical discussion by Gustav Wilhelm Meyer. 3,000 w. Elektrotechnische Zeitschrift—Jan. 28, 1897. No. 11,434. 15 cts.

ARMOUR Institute.

Power Plant of Armour Institute of Technology. Illustrated description of the new equipment made necessary by the increased demands for lighting and motor service. 1,000 w. W Elec—Feb. 27, 1897. No. 11,235. 15 cts.

CONVERTERS.

Rotary Converters. Ernst Julius Berg. Their action and the conditions under which their use is desirable, and the reaction of these machines on the alternating system, their methods of operation and the limitations imposed by their use. 2,300 m. Am Elect'n—Feb., 1897. No. 11,216. 15 cts.

DYNAMO.

Dynamo Characteristics.—Wilbur M. Stine. Showing that the characteristic occupies the same practical relation to the dynamo that the indicator does to the steam engine, and gives directions that will enable any one in charge of a dynamo, who possesses a good voltmeter and ammeter, to correctly lay down the several curves of his machine. 1,400 w. Am Elect'n—Feb., 1897. No. 11,220. 15 cts.

Westinghouse Dynamos. (Machines, Dynamo-électriques de la Compagnie Electrique "Westinghouse.") An extended description of the Westinghouse gen-

erators and motors from a French point of view. 12,000 w. La Revue Technique Feb. 10, 1897. No. 11,412. 30 cts.

EFFICIENCY.

The Efficiency of Direct Current Dynamos and Motors. Explanation of the terms employed, with table giving equivalent volts for efficiencies ranging from 60 to 95 per cent. 1,600 w. Elec, Lond—Jan. 29, 1897. No. 11,025. 30 cts.

EMERGENCIES.

An Interesting Example of Practical Expedients. Illustrated description of the rapid and interesting work in re-establishing the service of the Newark, N. J., electric light and power station after the fire. 1,700 w. Am Elect'n—Feb., 1897. No. 11,215. 15 cts.

FARM.

Electricity on a Farm. Brief illustrated description of the utility and advantages of electricity in farm and dairy operations as used on the dairy farm of Mr. Levi P. Morton. 1,000 w. Elec Wld—Feb. 6, 1897. No. 10,972. 15 cts.

GAS Engine.

The Gas Engine for Electrical Purposes. See Gas Engine, under Mechanical Eng'ng—Engines and Motors.

GENERATOR.

Tests of 200-Killowatt Continuous Current Parsons Turbo-Generator. W. D. Hunter. Describes a series of tests for the purpose of determining the steam consumption under different conditions of service and various grades of output. 400 w. Elec Rev, Lond—Feb. 19, 1897. No. 11,275. 30 cts.

INDICATOR.

A New Frequency Indicator. Account of an instrument invented by G. W. Meyer, for indicating the frequency of oscillating currents, depending on the fact that the heat generated in a wire magnetized by these currents is proportional to their frequency. 800 w. Elec Rev, Lond—Feb. 19, 1897. No. 11,276. 30 cts.

LACHINE.

The Lachine Rapids Power Plant, Montreal, P. Q. Wm. L. Bishop. Illustrated detailed description of the plan for power development. 4,500 w. Eng News—Feb. 18, 1897. No. 11,128. 15 cts.

MALTBY.

Maltby Electric Plant. Frederic C. Whitmore. Illustrated description of a successful electric hoisting and pumping plant, showing how difficult conditions were overcome by the use of electricity as a means of transmitting power at the Lehigh Valley Coal Co.'s Maltby Mine. 2,000 w. Col Eng—Feb., 1897. No. 11,065. 30 cts.

POWER Plants.

The Power Plants of Two Large Department Stores. Illustrated detailed description of the power and electric plants of the Chicago and New York stores of Siegel, Cooper & Co. 3,500 w. Power—March, 1897. No. 11,346. 15 cts.

SWITCH-GEAR.

A Few Practical Notes on Alternate-Current Switch-Gear. L. Andrews. Read before the Northern Soc. of Elec. Engs. Part first describes a safety device and cut-out, with introductory remarks. 1,100 w. Elec Eng, Lond—Jan. 29, 1897. Serial. 1st part. No. 10,981. 30 cts.

TORQUE.

The Torque of the Triplex Pump. Cyrus T. Brown. Showing the advantage in using the triplex pump, rather than the single plunger or double-acting pump when driven by an electric motor. 1,000 w. Am Mach—March 4, 1897. No. 11,350. 15 cts.

TRANSFORMERS.

Faults and How to Find Them. Discusses faults in transformers. 1,600 w. Prac Eng—Feb. 12, 1897. No. 11,159. 30 cts.

TRANSMISSION.

The Long-Distance Transmission of Power at Hartford. Illustrated description of the engineering problems, of which the recent extensive changes made in the system are considered a satisfactory solution. 1,800 w. Elec Wld—Feb. 13, 1897. Serial. 1st part. No. 11,037. 15 cts.

A 10,000-Volt Transmission Plant. Walter King. Abstract of an article in the Elektrotechnische Zeitschrift. Illustrated description of the transmission from Eichdorf to Grünberg. 1,300 w. Elect'n—Feb. 5, 1897. No. 11,081. 30 cts.

TELEGRAPHY AND TELEPHONY.

BERLINER.

The Berliner Microphone Case. E. F. Frost. Believing that there is a misconception of the Berliner case, the writer gives a statement explanatory of the question. 1,700 w. Elec Wld—Feb. 27, 1897. No. 11,257. 15 cts.

CABLE.

The "Rapid Cable." Comments on an article in the "Pall Mall Gazette," in which the construction of the cable as recommended by Silvanus P. Thompson is discussed. 2,000 w. Elec Rev, Lond—Jan. 29, 1897. No. 10,982. 30 cts.

SUBMARINE.

Sixty Years of Submarine Telegraphy. W. E. Ayrton. Abstract of a lecture delivered at the Imperial Inst. Historical review. 5,000 w. Elect'n—Feb. 19, 1897. No. 11,274. 30 cts.

SWITCH.

Watson Telephone Switch Patent Held to Be Invalid for Want of Novelty. The text of Judge Showalter's opinion, with reproductions of drawings in the patent. 2,800 w. W Elec—Feb. 20, 1897. No. 11,146. 15 cts.

TELEGRAPHY.

Telegraphing Without Wires. H. J. W. Dam. Gives interviews with Dr. Bose and Signor Marconi and explains their investigations in this field. Ill. 7,400 w. McClure's Mag—March, 1897. No. 11,229. 15 cts.

TELEPHONY.

American Telephone Practice. Kempster B. Miller. Illustrated description of battery transmitters. 1,500 w. Am Elect'n—Feb., 1897. No. 11,222. 15 cts.

The Future Developments of Telephony. (Die Gegenwärtige Entwickelung des Fernsprechwesens.) An elaborate paper read before the Electrotechnic Society in Berlin by Jul. H. West. Proposes to cover the country with a network system of long-distance wires to be worked in connection with central stations. Two articles. 15,000 w. Elektrotechnische Zeitschrift—Feb. 4 and 11, 1897. No. 11,437, 30 cts.

TRANSMITTERS.

Telephone Transmitters. Dr. V. Weitlisbach. Illustrated description of the construction and working of transmitters based on the two fundamental types—contact, and powder or grain transmitters. 4,000 w. Elec Engng—March, 1897. Serial. 1st part. No. 11,139. 15 cts.

MISCELLANY.

ALTERNATING Current.

Mechanical Representation of Electrical Phenomena and Investigations of Resonance of Alternating Currents. (Mechanische Hülfsvorstellungen bei elektrischen Vorgängen und Untersuchungen über Wechselstromresonanz.) An elaborate mathematical treatment by Dr. Heinke, of Munich. 12,000 w. Elektrotechnische Zeitschrift—Feb. 4, 1897. No. 11,435. 15 cts.

BATTERY.

Electric Bells and Batteries. W. A. Wittbecker. From Carpentry and Building. Discusses batteries, describing their chemical action and means of detecting a weak battery, with some points on the adjustment of bells. 1,500 w. Met Work—Feb. 13, 1897. No. 11,003. 15 cts.

CARBON.

Electricity from Carbon Without Heat. Willard E. Case. A lecture delivered before the N. Y. Elec. Soc., Feb. 24. A résumé of the subject, giving the essential features of the devices thus far employed to oxydize carbon without heat, and suggesting the line along which the writer thinks success most probable. 5,000 w. Elec Eng—March 3, 1897. No. 11,320. 15 cts.

CARBON.

The Transition of Carbon from the Non-Conducting Into the Conducting Condition. George Brion. Investigations to determine at what temperature and in what manner this transition of carbon from the non-conducting to the conducting condition takes place. Abstract from Wied. Ann. 1,800 w. Elect'n—Feb. 5, 1897. No. 11,080. 30 cts.

CIRCUIT.

Calculation of Circuit. Frederic A. C. Perrine. The proper use of the different kinds of insulation under varying conditions; the selecting of a conductor for carrying a definite amount of energy; size of wire and all related topics are discussed. Illustrations and diagrams. 8,000 w. Elec Engng—March, 1897. No. 11,140. 15 cts.

DEAD Wire.

Dead Wire on Armatures. Richard Pfund. Gives the writer's reason for the wire on the inside not being as active in developing e. m. f. as that on the outside. 800 w. Elec Eng—Feb. 10, 1897. No. 10,786. 15 cts.

DIELECTRICS.

Some Dielectrics and Their Insulating Properties. George T. Hanchett. Practical consideration of exceptions to the results given of the dielectric strength of insulators as measured by formulas. 1,000 w. Elec Wld—Feb. 6, 1897. No. 10,971. 15 cts.

EARTH.

The Earth as a Conductor. Dr. Louis Bell. A study of the value of the earth as a conductor and its limitations. Only in telegraphy does it appear to serve a permanently useful purpose. 2,400 w. Am Elect'n—Feb., 1897. No. 11,218. 15 cts.

ELECTROMAGNETS.

Economy in the Design of Electromagnets. W. E. Goldsborough. The writer believes that the best results are to be obtained by working just below rather than just above the knee of the magnetism curve, although the latter is the usual practice. 700 w. Elec Wld—Feb. 6, 1897. No. 10,973. 15 cts.

ELECTROTECHNICS.

Electrotechnics, at the Hungarian Millenial Exposition (Die Elektrotechnik in der Millenniums-Landesausstellung zu Budapest.) Giving illustrated descriptions of electric tools, motors, locomotives, &c., shown at Budapest. 4,500 w. Zeitschr. d. Vereines Deutscher Ingenieure—Jan. 30, 1897. No. 11,404. 30 cts.

FIRE-ALARM.

Test of Fire-Alarm Boxes. Report of the findings of the commission selected to test the fire-alarm boxes of Chicago, with brief editorial comment. 2,500 w. W Elec—Feb. 13, 1897. No. 11,006. 15 cts.

FIRE Risk.

Fire Risks at Electricity Works. G. Pearson. A discussion of the question, considering some of the suggestions made for solving the problem of municipal insurance with the difficulties. 2,800 w. Prac Eng—Feb. 5, 1897. No. 11,082. 30 cts.

Insurance as Affected by Electrical Construction. G. S. McLaren. Abstract of a paper read before the Northwestern Elec. Assn. Discusses the position taken by underwriters in regard to the use of electricity, and calls attention to dangers to be avoided. 1,500 w. Elec Eng—Feb. 10, 1897. No. 10,985. 15 cts.

FITTINGS.

A New System of Electrical Fittings (Ueber ein neues System von Installations und Sicherungsmaterialen.) A pa-

per read before the German Electrotechnical Society by Herr Hundhausen, describing the connections, conductors, fittings, &c., used by Messrs. Siemens & Halske. 9,000 w. Elektrotechnische Zeitschr—Jan. 14 and 21, 1897. No. 11,430. 30 cts.

GAS.

Gaseous Fuel as a Means of Cheapening Electricity. Nelson W. Perry. Read before the Northwestern Elec. Assn. at Milwaukee. A discussion of the subject, and suggestions of means for securing the best economical results. 4,400 w. W Elec—Feb. 13, 1897. No. 11,005. 15 cts.

HYSTERESIS.

Calculation of Loss from Hysteresis. (Zur Berechnung der Eisenverluste in Alternatoren der sogenannten Induktortyps.) A mathematical treatment of the subject by Dr. Behm-Eschenberg. 1,000 w. Elektrotechnische Zeitschrift—Jan. 14, 1897, No. 11,428. **15 cts.**

Calculation of Loss from Hysteresis in Grooved Armatures. (Zur Berechnung von Eisenverlusten in Nuthenankern.) Treated analytically and graphically by Dr. Max Breslauer, of Frankfurt a. M. 1,500 w. Elektrotechnische Zeitschrift—Feb. 11, 1897. No. 11,438. 15 cts.

ISOLATED Plant.

Electricity at the Hebrew Technical Institute, New York. Illustrated detailed description. 1,500 w. Elec Eng—March 3, 1897. No. 11,319. 15 cts.

ROENTGEN Rays.

Improved Tubes for Roentgen Rays. (Ueber eine Verbessurung an den Roentgenrohren.) Discusses the various methods of diminishing the injurious effect of the bombardment upon the walls of the Crookes tube, describing the apparatus of Porter, Fomm, and the author, Dr. Arnold Berliner. 1,500 w. Elektrotechnishe Zeitschrift—Feb. 11, 1897. No. 11,439. 15 cts.

The Roentgen Ray and Its Relation to Physics. A topical discussion. Prof Henry A. Rowland makes the opening remarks and is followed by M. I. Pupin, Elihu Thomson, A. E. Kennelly and others. 19,000 w. Trans Am Iinst of Elec Engs—Dec., 1896. No. 11,232. 45 cts.

SWITCH Gear.

A Few Practical Notes on Alternate Current Switch-Gear. L. Andrews. Read before the Northern Soc. of Elec. Engs. Description and a diagram of a safety device used by the writer, with record of its action. 3,000 w. Ind and Ir—Feb. 12, 1897. Serial. 1st part. No. 11,196. 30 cts.

THREE-PHASE System.

Saving of Copper in Three-Phased Transmission Lines. Defines a three-phased system and gives method of calculating the comparative amounts of copper required for three-phase and for single alternating current systems. 1,200 w. Am Elect'n—Feb., 1897. No. 11,219. 15 cts.

X RAY.

How to Keep X-Ray Tubes in Condition While Working. Max Osterberg. Suggestions tending to prolong the life of tubes and to keep them in the best condition. 800 w. Elec Eng—Feb. 10, 1897. No. 10,984. **15 cts.**

MARINE ENGINEERING.

BOILERS AND ENGINES.

BEARINGS.

See "Bearings," under Mechanical Engineering, Miscellany.

DRAUGHT.

Suction Draught for Marine Boilers. Matthew Paul. Abstract of a paper read before the Inst. of Engs. and Shipbuilders in Scotland. The results of tests and experience are given. It was claimed that in safety of boilers under high rates of steaming, economy of coal, ease and simplicity of working and structural arrangements, suction draught had distinct advantage over forced draught. 2,800 w. Eng, Lond.—Feb. 5, 1897. No. 11,030. 30 cts.

DUTY Test.

A Method of Determining a Continuous Record of the Performance of a Marine Engine. W. F. Durand. Discusses the desirability of continuous records and considers the elements involved in them and the ways and means of obtaining them. 500 w. Jour Am Soc of Nav Engs—Feb., 1897. No. 11,154. $1.25.

NAVAL AFFAIRS.

BATTLESHIP.

The Japanese Battleship "Yoshima." Brief illustrated description. 2,000 w. Engng—Feb. 5, 1897. No. 11,023. 30 cts.

COMPRESSED Air.

Proposed Extension of the Use of Compressed Air on Men-of-War. See title. Naval Use, under Mechanical Engineering—Compressed Air.

The U. S. S. Terror and the Pneumatic System as Applied to the Guns, Turrets and Rudder. T. W. Kinkaid. General data of the ship and machinery, with illustrated description of the pneumatic system. 3,000 w. Jour Am Soc of Nav Engs—Feb., 1897. No. 11,155. $1.25.

DRY Docks.

The Timber Dry Docks at the Brooklyn Navy Yard. Illustrated detailed description of new dock No. 3, construction, cost, &c. 1,800 w. Sci Am—Feb. 20, 1897. No. 11,103. 15 cts.

SEARCH Light.

See same title under Electrical Engineering—Lighting.

SPEED.

The Speed Problem. J. A. Normand.

Read before the Assn. Technique Maritime, Paris. A study of the speed of torpedo boats, the causes of recent progress and the possible causes for future progress. 3,200 w. Jour Am Soc of Nav Engs—Feb., 1897. No. 11,156. $1.25.

WARSHIPS.

Modern Warships. (Die heutige Kriegsmarinen.) Von Neudeck. Illustrated and tabulated descriptions of the most recent Italian and Russian warships. 5,000 w. Zeitschr d Vereines Deutscher Ingenieure—Jan. 30, 1897. No. 11,406. 30 cts.

MISCELLANY.

DIVING.

Some Facts About Diving Apparatus, &c. Discusses the business of Messrs. Barnett and Foster, specialists in the matter of diving apparatus. 2,300 w. Trans—Feb. 12, 1897. No. 11,183. 30 cts.

FREIGHT Steamer.

The Pennsylvania, the Largest Freight Steamer in the World. Illustrated description. 900 w. Sci Am—Feb. 27, 1897. No. 11,210. 15 cts.

FUEL.

Liquid Fuel. R. R. Wallis. Read before the Northeast Coast Inst. Applies to the use of petroleum residues on board of steamships. 2,500 w. Prac Eng—Feb. 19, 1897. No. 11,277. 30 cts.

MERCANTILE Marine.

New Laws in Japan for the Development of the Mercantile Marine. Gives the text of two laws for the development of the Japanese Mercantile Marine and the encouragement of shipbuilding in that country. 1,800 w. Bd of Trd Jour—Feb., 1897. No. 11,295. 30 cts.

The American Mercantile Marine. Comment on the report of the Commissioner of Navigation, dealing with the laws of the United States relative to navigation. 2,400 w. Bd of Trd Jour—Feb., 1897. No. 11,294. 30 cts.

ROLLER Ship.

Bazin Roller Ship. (Der Rollendampfer "Ernest Bazin.") Line drawing, with dimensions and other data, of the Bazin vessel about completed for use on the Channel. 1,000 w. Zeitschr d Oesterr Ing u Arch Vereines—Jan. 22, 1897. No. 11,423. 15 cts.

NAPHTHA Launch.

The Naptha Launch of the Gas-Engine and Power Company of New York City. Illustrated description. 900 w. Sci Am Sup—Feb. 27, 1897. No. 11,213. 15 cts.

PROJECTORS.

See same title under Electrical Engineering—Lighting.

SHIPBUILDING.

German Shipbuilding. (Deutsche Werften.) A review of shipbuilding going on at present in the leading German yards, with illustrations of the new North German Lloyd Steamer "Kaiser Friedrich." 3,000 w. Zeitsch d Vereines Deutscher Ingenieure—Jan. 30, 1897. No. 11,405. 30 cts.

SHIPPING.

Projected Steamship Enterprises. Some account of the interest the Japanese are giving to shipping interests, and the effect upon trade that could be expected if the shipping facilities were improved. 2,000 w. Nat Assn of Mfrs—Circ. No. 11. No. 11,174. 45 cts.

STEERING Gear.

Electric Steering Gear. (Elektrische Steuerruder Maschine.) Illustrated description of Essberger's electric steering engine, now being applied in the German Navy. Two motors running in opposite directions are geared to an epicyclic train, and one or the other overruns according to the motion of the controlling lever. 2,000 w. Elektrotechnische Zeitschrift—Feb. 4, 1897. No. 11,436. 15 cts.

VIBRATION.

The Prevention of Vibrations of Steamships. John H. Macalpine. The object of the paper is to show how, by mechanical means, the vertical transverse vibrations of the periods higher than the first may be almost entirely prevented. 5,800 w. Engng—Feb. 19, 1897. No. 11,304. 30 cts.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

BOILER Defects.

Defects in Steam Boilers. Abstract from the second report of the committee of the Austrian Soc. of Engs. and Archts., relating to stationary boilers. Ill. 3,300 w. Eng News—Feb. 11, 1897. No. 11,019. 15 cts.

BOILER Scale.

Incrustations in Boilers. (Incrustants et Désincrustants.) M. Dibos. An investigation into the causes and character of boiler incrustations, with analyses and suggestions for remedies. Especially referring to marine boilers. 6,000 w. La Revue Technique—Jan. 25, 1897. No. 11,408. 30 cts.

EXPLOSIONS.

Heat and Boiler Explosions. James Wright. Paper read before Montreal C. A. S. E. Briefly outlines the views held as to what heat is, considers the mechanical equivalent and the behavior of water when subjected to heat. 4,500 w. Can Elec News—Feb., 1897. No. 10,970. 15 cts.

Boiler Explosions and Failures from Hidden Defects. From "The Locomotive." Illustrated description of causes of failures. Fractured plates, hidden cracks, possible in all types of boilers that have riveted shells and lap joints. 2,000 w. Age of St—Feb. 27, 1897. No. 11,272. 15 cts.

FEED-WATERS.

The Cure for Corrosion and Scale from Boiler Waters. Albert A. Cary. Describing the phenomena of pitting, grooving

and general corrosion, the theories offered in explanation of them, and the means of their prevention. Ill. 6,800 w. Eng Mag—March, 1897. No. 11,341. 30 cts.

FURNACE Gases.

The Presence of Hydrogen, Hydrocarbons and Nitrogen Peroxide in Boiler Furnace Gases. R. S. Hale. Collection of data showing that, though the presence of the nitrogen peroxide accounts for the missing oxygen, yet the amounts of carbon dioxide, oxygen and carbonic oxide in the gas can in no case prove the absence of hydrogen or hydrocarbons. 1,200 w. Eng News—Feb. 18, 1897. No. 11,130. 15 cts.

FUSIBLE Plug.

Fusible Plugs in Boilers. W. A. Carlile. Describes the principal types of fusible plugs and states their advantages and disadvantages. 2,300 w. Safety V—Feb., 1897. No. 11,042. 15 cts.

GAGES.

Water-Gages for High-Pressure Steam Boilers. T. C. Billetop. Read before the Northeast Coast Inst. of Engs. and Shipbuilders. Presents the advantages of the talc gage, with diagram. 1,500 w. Col Guard—Feb. 12, 1897. No. 11,169. 30 cts.

INJECTOR.

The Injector. J. Warren. Describes briefly the theory and construction, with the methods of working. 1,600 w. Elec, Lond—Jan. 22, 1897. No. 11,024. 30 cts.

SAFETY Valve.

Safety-Valves on Low-Pressure Boilers. Criticises the practice of placing of safety-valves of insufficient area of opening. 1,300 w. Bos Jour of Com—Feb. 27, 1897. No. 11,261. 15 cts.

STOKING.

Machine Firing. Edward Bennis. Review of attempts in the direction of machine firing, with description of the construction and work of a machine. Discussion follows. 3,800 w. Col Guard—Feb. 5, 1897. No. 11,078. 30 cts.

COMPRESSED AIR.

AIR Lift Pumps.

See same title under Municipal Engineering—Water Supply.

COMPRESSED Air.

Advantages of Compressed Air. Jas. F. Lewis. A very complete history of the progress of this power from the earliest recorded experiments to the present day, giving its numerous uses. Ill. 7,000 w. Can Min Rev—Feb., 1897. No. 11,330. 30 cts.

Compressed Air. Some of the uses to which it is being put in different ways. 1,300 w. Bos Jour of Com—Feb. 20, 1897. No. 11,161. 15 cts.

ELECTRIC Power.

Compressed Air vs. Electricity. Fredk. S. Watkins. Briefly compares the first cost, efficiency, cost of operation, reliability and difficulties. 1,000 w. Compressed Air—Feb., 1897. No. 11,111. 15 cts.

Fairness in Comparing Air and Electric Power. Editorial advising the partisans of each power to devote their energies to the selection of the legitimate field and the development of the power in which they are interested. 1,000 w. Ry Rev—Feb. 27, 1897. No. 11,308. 15 cts.

Is Compressed Air Destined to Become the Rival of Electricity? Joseph W. Buell, in Inventive Age. Discusses the changes brought about by electricity, gives history of the early attempts to use compressed air, and a brief account of the power yielded and applications. 2,400 w. Compressed Air—Feb., 1897. No. 11,110. 15 cts.

MARINE Uses.

See title Compressed Air under Marine Engineering, Naval Affairs.

NAVAL Use.

Proposed Extension of the Use of Compressed Air on Men-of-War. F. W. Bartlett. Suggests ways of using air and states why it is better for many purposes than either steam or electricity. 1,700 w. Am Mach—Feb. 18, 1897. No. 11,123. 15 cts.

PNEUMATIC Tubes.

Locating Obstructions in Underground Pneumatic Tubes in Philadelphia. B. C. Batcheller. An interesting account of efforts made based on the velocity of sound waves, and the degree of success attained. 1,700 w. Eng News—March 4, 1897. No. 11,353. 15 cts.

SHOP Use.

Pneumatic Power Applied to Workshops. John Davis Barnett. From the Trans. of the Can. Soc. of Civ. Engs. The present position of air power, as part of a craft, illustrated more especially by railway shop work. 4,800 w. Prac Eng—Feb. 5, 1897. No. 11,083. 30 cts.

RAILROAD Use.

See title Snow-Flanger under R. R. Affairs—Equipment.

ENGINES AND MOTORS.

CONDENSERS.

Central Condensers. (Ueber Central-Condensation.) A description of condensing plant in which a number of engines exhaust into one large condenser; with illustrations of the apparatus at the "Ewald" mine in Westphalia. 4,000 w. 1 plate. Zeitschr. d. Oesterr. Ing. u. Arch Vereines—Jan. 22, 1897. No. 11,421. 15 cts.

DUTY Tests.

Efficiency of Different Types of the Steam Engine. Comparisons made on the basis of engines working in a Carnot cycle are given in part first. 1,200 w. Am Elect'n—Feb., 1897. Serial, 1st part. No. 11,217. 15 cts.

See same title under Marine Engineering, Engines and Boilers, and Mechanical Engineering Miscellany.

DYNAMO.

See Electrical Engineering—Power.

GAS-ENGINE.

Discussion: "The Large Gas Engine; Its Present Development and Forecast of Its Future." Discussion of Mr. Lloyd's paper at the annual meeting of the Ohio Gas Lgt. Assn. 3,000 w. Am Gas Lgt Jour—Feb. 22, 1897. No. 11,194. 15 cts.

Gas and Gasoline Engines. M. T. Monogue. Endeavors to explain the care needed, the troubles arising and remedies, in this class of machinery. 1,100 w. Sci Mach—March 1, 1897. No. 11,321. 15 cts.

The "Cosmos" Gas Engine. Moteur à Gaz, "Cosmos." Illustrated description of a very neat and simple vertical gas engine recently brought out in Paris. 1,000 w. La Révue Technique—Feb. 10, 1897. No. 11,415. 30 cts.

The Large Gas-Engine. Its Present Development and Forecast of Its Future for Electrical Purposes. E. F. Lloyd. Brief review of the single-acting and double-acting engines and the advantages and improvements in detail and construction. 4,000 w. Am Gas Lgt Jour—Feb. 15, 1897. No. 11,033. 15 cts.

INDICATOR.

The Steam-Engine Indicator. Discusses the faulty points and lines, giving a series of cards showing some of the incorrect positions and illustrating remedies. 1,400 w. Prac Eng—Feb. 12, 1897. No. 11,160. 30 cts.

MOTOR.

Designs for Small Motors. Cecil P. Poole. Part first gives working drawings for the construction of a 1-6 h.-p. motor with drum armature, for operation upon a 110-volt continuous-current circuit, with descriptions. 1,800 w. Am Elect'n—Feb., 1897. Serial. 1st part. No. 11,221. 15 cts.

SLIDE-VALVE.

The Slide Valve Diagram. Treats merely of the practical construction. 1,400 w. Am Elect'n—Feb., 1897. No. 11,226. 15 cts.

TURBINE.

High-Pressure Turbine Wheel, with Hydraulic Regulator. (Hochdruk-Turbine mit hydraulischer Patent-Regulierung). A turbine of the Pelton type, controlled by a centrifugal governor and differential hydraulic gear, constructed by Theo. Bell & Cie, of Kriens, Switzerland. 1,000 w. Schweizerische Bauzeitung—Feb. 6, 1897. No. 11,448. 15 cts.

POWER AND TRANSMISSION.

BEARINGS.

Machinery Bearings. John Dewrance. The results of a series of experiments undertaken to determine the frictional resistance to shafts revolving in bearings under varying loads, when subjected to different conditions. Also "The Bearings of the Marine Engine." Ill. 6,500. Jour Am Soc of Nav Engs—Feb., 1897. No. 11,157. $1.25.

BELTING.

Notes on Belting. Fred W. Taylor. A paper presented to the A. S. M. E. three years ago, but reprinted because of its value as a complete treatise on the subject. 4,500 w. Eng, Lond—Feb. 5, 1897. Serial. 1st part. No. 11,028. 30 cts.

MINING.

Power Transmission for Mining Work. See Power Transmission under Mining and Metallurgy, Mining.

PAPER WHEELS.

Paper Wheels for Transmission of Power. George D. Rice. Report on a series of experiments which were undertaken with the view of determining the practicability and efficiency of paper wheels for the transmission of power. 1,000 w. Ir Age—Feb. 11, 1897. No. 10,993. 15 cts.

SHOP AND FOUNDRY.

BRASS MOLDING.

A Pattern for a Difficult Brass Casting. Charles H. Allmond. Describes the casting of a very thin receiver pipe for a triple-expansion engine. 800 w. Am Mach—Feb. 18, 1897. No. 11,119. 15 cts.

CHILLED ROLLS.

A Method of Casting Chilled Rolls. Cuts and description taken from a pamphlet issued by the Lewis Foundry and Machine Co., of Pittsburg. 2,000 w. Ir Trd Rev—Feb. 25, 1897. No. 11,255. 15 cts.

CHIPS.

Helical and Spiral Chips—Easy Rolling Chips. Tecumseh Swift. Calling attention to the fact that the chip made on the lathe is helical, while the chip made on the planer is spiral. 1,500 w. Am Mach—Feb. 11, 1897. No. 10,998. 15 cts.

DRESSING.

A New Method of Dressing Car Wheels, Axles, etc. See Car Wheels, Axles, etc., under Railway Affairs—Equipment.

DRUMS.

Strength of Hoisting Drums. Charles Lewis. Analysis of the strains. 800 w. Am Mach—Feb. 11, 1897. No. 10,997. 15 cts.

EMBOSSING.

Embossing Presses. (Nouvelles Presses à Emboutir.) Illustrated description of the American presses of the E. W. Bliss Co. 2,000 w. La Revue Technique—Jan. 25, 1897. No. 11,411. 30 cts.

FLY-WHEELS.

De La Vergne Fly-Wheels. An illustrated detailed description of the construction of these wheels. 1,600 w. Am Mach—Feb. 11, 1897. No. 10,995. 15 cts.

GAGING.

Correct Gaging in Mounting Car Wheels. See title Car Wheels under Railroad Affairs—Equipment.

GEARS.

Gear Molding and Gear Molding Machines. S. Groves. Read before the Nat. Foundrymen's Convention. Some particulars and practical details noted in the process of actual manufacture. Ill. 2,400 w. Foundry—Feb., 1897. No. 11,127. 15 cts.

The Strength of Gear Teeth. Henry Hess. Diagrammatic solution of the load that may be imposed on a gear tooth, with discussion of formulae. 1,500 w. Am Mach—Feb. 18, 1897. No. 11,121. 15 cts.

GRINDING MACHINE.

The Use of the Grinding Machine. John Randol. Some ideas and occurrences from the writer's observation and experience, and also information from the

Brown & Sharp Mfg. Co. Ill. 4,000 w. Am Mach—Feb. 25, 1897. No. 11,204. 15 cts.

HEAD STAMPING.

Lock Joint Head Stamping. How to Make It and the Tools for It. W. A. Warman and Thomas A. Dicks. Describes a process which gives a stamping in which the metal is thicker by 10 to 20 per cent. at the points of greatest strain. Ill. 1,200 w. Am Mach—Feb. 25, 1897. Serial. 1st part. No. 11,203. 15 cts.

LAP-WELDING.

Making Lap-Welded Pipe. Describes the process of manufacture as carried out at the plant of the National Tube Works Company, at McKeesport, Pa. 1,200 w. Am Mfr & Ir Wld—Feb. 19, 1897. No. 11,184. 15 cts.

LATHE.

One Million Shapes for a Diamond-Point Lathe Tool. How to Designate Them. Tecumseh Swift suggests a scheme for accurately describing and recording the shape of the cutting point of the tool. 1,500 w. Am Mach—Feb. 18, 1897. No. 11,122. 15 cts.

MOLDING.

Molding Hawse Pipes at the Bath Iron Works Foundry. George W. Dean. Illustrated, description. 900 w. Am Mach—Feb. 11, 1897. No. 10,996. 15 cts.

The Bryant Revolving Molding Machine. Illustrated description of the invention of Orrin Bryant. 800 w. Eng News—Feb. 18, 1897. No. 11,132. 15 cts.

SHOP Management.

Six Examples of Successful Shop Management. Henry Roland. Showing the decline of the contract system in machine shops. 3,200 w. Fifth paper. Eng Mag—March, 1897. No. 11,344. 30 cts.

MISCELLANY.

AMERICAN Machinists and Tools.

American Machine Tools and Other Products as Seen Through Foreign Eyes. Substance of an interview with Herr Von Meyenburg, a Swiss engineer, with editorial. Claims that American tools are better, but machines inferior. 2,800 w. Am Mach—March 4, 1897. No. 11,351. 15 cts.

APPRENTICESHIP System.

The Improvement of the Apprenticeship System as a School for Mechanics. Discussion of the relation of employer and apprentice and the means of making this system of value, with reasons. 2,800 w. Eng News—March 4, 1897. No. 11,355. 15 cts.

CONVEYORS.

Coal Handling Plant of Coxe Bros. & Co., Clybourne Ave. Docks, Chicago, Ill. Illustrated detailed description. 2,300 w. Eng News—Feb. 11, 1897. No. 11,016. 15 cts.

DUTY TESTS.

Watt and the Measurement of Power. W. H. Preece. The Watt Anniversary Lecture, delivered at Greenock, Feb. 5. An interesting discourse, dealing largely with Watt's measurement of power and its present use, with editorial comment. 4,500 w. Elect'n—Feb. 12, 1897. No. 11,189. 30 cts.

HEAT Transmission.

Transmission of Heat Through Metal Plates. (Ueber den Wörmedurchgang durch Metallplatten.) Report upon experimental determination of transmission of heat through plates of steel of various thickness for various differences of temperature. 1,500 w. Zeitschr. d. Oesterr. Ing u Arch Vereines—Jan. 29, 1897. No. 11,425. 15 cts.

INVENTION.

Cultivation of the Inventive Capacity by the Solution of Constructive Problems. Leicester Allen. Presents problems and gives solutions. Ill 2,200 w. Am Mach—March 18, 1897. No. 11,120. 15 cts.

LUBRICATION.

Superficial Tension and Lubrication. R. M. Deeley. The phenomena arising from superficial tension are studied in so far as they concern lubricating problems. 6,300 w. Eng, Lond—Feb. 12, 1897. No. 11,166. 30 cts.

MACHINES.

Dissimilar Action of Similar Machines. William Baxter, Jr. Considers the causes that tend to vary the action of machines. 2,800 w. Elec World—Feb. 20, 1897. No. 11,188. 15 cts.

METRIC System.

The Metric System Lunacy. Part first criticises statements made by Frederick A. P. Barnard, and arguments tending to show that the measurements now used are better. 2,800 w. Engng Mech—Feb., 1897. Serial. 1st part. No. 11,271. 30 cts.

MILL.

Roller Mill. (Moulin à Blé à Cylindres.) Detailed description, with illustrations and plate showing plans of building, of a roller mill of 6,000 lbs. capacity in 24 hours, erected at Soulièvre. 4,000 w. La Revue Technique—Jan. 25, 1897. No. 11,409. 30 cts.

SMOKE Prevention.

The Suppression of Smoke by the Use of Coke. O. Simmersbach, in Zeitschrift der Dampfkessel-Ueberwachungs-Vereine. Treats of the substitution of coke for coal and arrives at the conclusion that general heating by coke is practicable, and presents important technical and economical advantages. 5,500 w. Pro Age—Feb. 15, 1897. No. 11,117. 15 cts.

TESTING.

Mechanical and Physical Tests Compared. S. S. Knight. The writer believes the best results will be attained by the use of both chemical and mechanical tests. 3,000 w. Foundry—Feb., 1897. No. 11,126. 15 cts.

Mirror Apparatus for Testing. Gus C. Henning. Explains what a mirror apparatus really is, and gives illustrated description of design by the writer. 1,500 w. Am Mach—Feb. 11, 1897. No. 10,994. 15 cts.

MINING AND METALLURGY.

COAL AND COKE.

AUSTRALIA.
Coal in Western Australia. Report of H. P. Woodward, government geologist, on the carboniferous areas of the Irwin River basin. 1,600 w. Col Guard—Feb. 5, 1897. No. 11,075. 30 cts.

BLOCK Coal.
The Block Coal Region of Indiana. Brief description of location, appearance, manner of working, &c. 800 w. Eng & Min Jour—Feb. 13, 1897. No. 11,011. 15 cts.

FRANCE.
Colliery Working in the Loire, France. M. Tauzin. From an official report by the government inspector. Deals with production, methods of working, wages, ventilation, explosives, pumping, &c. 1,500 w. Col Guard—Feb. 19, 1897. No. 11,300. 30 cts.

MACHINE Mining.
Coal Cutting Machines. Cyrus Robinson. The comparative advantages and disadvantages of compressed air and electrically driven machines over pick mining. 1,200 w. Col Eng—Feb., 1897. No. 11,069 30 cts.

NEVADA.
The Coal Fields of Esmeralda County, Nev. M. A. Knapp. A description of this coal field and its interesting stratigraphical relations. 1,400 w. Min & Sci Pr—Feb. 13, 1897. No. 11,102. 15 cts.

HOCKING Valley.
The Hocking Valley Coal Region in Ohio. (Describes the character of the coal, methods of mining, ventilation, &c. 800 w. Eng & Min Jour—Feb. 27, 1897. No. 11,250. 15 cts.

COPPER.

ARIZONA.
Arizona's Copper Mines. Arthur Lakes. The Governor's report on the mineral resources of the territory and some observations by a prospector. 1,500 w. Col Eng—Feb., 1897. No. 11,068. 30 cts.

CALIFORNIA.
The Randsburg Mining District, California. F. M. Endlich. Gives a brief synopsis of the leading properties now in operation, with favorable report of the district. 1,900 w.) Eng & Min Jour—Feb. 27, 1897. No. 11,247. 15 cts.

REFINING.
Some Recent Developments in Copper Manufacture. Harold P. Brown. Analysis, tests and experiments with what is known as M. B. copper, proving its value to electrical engineers on account of high conductivity. 2,000 w. Elec Rev—March 3, 1897. No. 11,313. 15 cts.

GOLD AND SILVER.

ARIZONA.
Mining in Gavapai County, Arizona. John F. Blandy. Favorable account of the mining progress of this region, which has five leading gold mines. 800 w. Eng and Min Jour—Feb. 27, 1897. No. 11,249. 15 cts.

AUSTRALIA.
A Neglected Goldfield. An account of the Hodgkinson goldfield by the government geologist. 4,000 w. Aust Min Stand—Dec. 31, 1896. No. 11,000. 30 cts.

The Goldfields of Western Australia. Harry C. Rhys Jones. Considers the future of this region one of golden promise. 2,200 w. Aust Min Stand—Jan. 14, 1897. No. 11,093. 30 cts.

BRITISH COLUMBIA.
Notes on the Gold-Bearing Lodes of Cayoosh Creek, B. C. G. F. Moncton. The writer thinks there is good cause to believe this will become a famous mining camp, and gives reasons for his opinions. 1,600 w. Can Min Rev.—Feb., 1897. No. 11,331. 30 cts.

The Revival of Mining in Cariboo, B. C. Gives past history of this gold region and the arrangements recently made to develop the wealth of this district. 4,000 w. Can Min Rev.—Feb., 1897. No. 11,325. 30 cts.

COLOMBIA.
The Gold Fields of the Porce River, Colombia. J. D. Garrison. Reporting the results of the writer's examination of Colombian mines. Ill. 3,100 w. Eng Mag—March, 1897. No. 11,343. 30 cts.

FOLEY Mine, Ont.
The Foley Mine, Shoal Lake, Ont. Description, with illustrations, of this celebrated gold mine, giving character of ore deposits, development and expenditures. 500 w. Can Min Rev—Feb., 1897. No. 11,326. 30 cts.

GOLD Mining.
Future of Gold Mining. Editorial review of present conditions and causes which have affected gold mining, calling attention to considerations that demand adjustment. 1,000 w. Min Ind and Rev—Feb. 18, 1897. No. 11,180. 15 cas.

Gold and Silver Mining. C. C. Goodwin. Describes the finding of some successful mines and their output. 2,800 w. Chau—March, 1897. No. 11,228. 30 cts.

GOLD Quartz Mining.
Gold Quartz Mining in Canada and Victoria, Australia. Dr. A. R. Selwyn. Facts and comparisons relating to these fields, with discussion. 5,500 w. Can Min Rev—Feb., 1897. No. 11,334. 30 cts.

HUNGARY.
Visit of the Mining Congress of Budapest to the Boicza-Brâder Gold Fields. (Der Ausflug der Theilnehmer am montanistischen Congresse zu Budapest nach den Boicza-Brâder Goldbergbauen.) An interesting account of a trip of a body of specialists to the famous Hungarian gold mines. 8,000 w. Zeitsch d Oestrr Ing u Arch Vereines—Jan. 15 and 22, 1897. No. 11,407. 45 cts.

LOW GRADE Gold Ore.

Notes of the Mining of Low Grade Gold Ore in Nova Scotia. G. F. Andrews. An outline of the writer's personal experience while manager of the Richardson mine at Isaac's Harbor, Nova Scotia. 3,000 w. Can Min Rev—Feb., 1897. No. 11,332. 30 cts.

MADAGASCAR.

Gold Traffic and Gold Mining in Madagascar. A translation of the law concerning gold export and buying which seems to threaten trouble between local authorities and foreign merchants. 3,500 w. Cons Repts—Feb., 1897. No. 11,153. 45 cts.

MOUNT Morgan.

The Mount Morgan Gold Mine. Periodical report giving the fullest information as to the work done and the result. Ill. 2,500 w. Aust Min Stand—Dec. 24, 1896. No. 10,999. 30 cts.

NEW ZEALAND.

A New Zealand Gold Mine. Facts concerning the Houraki District, with illustrations of the Crown Mine. 500 w. Eng and Min Jour—Feb. 20, 1897. No. 11,147. 15 cts.

Gold Mining in New Zealand. C. C. Longridge. Warnings and suggestions, quoting opinions of the Government Inspecting Engineer. Also Editorial. 2,500 w. Min Jour—Feb. 6, 1897. No. 11,031. 30 cts.

Mining in New Zealand. C. C. Longridge. Nature of the gold, power, blasting, crushing and stamping, cyaniding, sluices, labor and cost are briefly noticed. 800 w. Min Jour. Feb. 13, 1897. No. 11,202. 30 cts.

OREGON.

The Claims of Oregon to Prominence as a Mining Region. Describes the chief mining region of the State, showing a profitable yield of gold and valuable copper deposits. 1,600 w. Min Jour—Feb. 20, 1897. No. 11,315. 30 cts.

PLACER.

The Gravel Fields of Northern California. C. L. Hall. Information of the placer mining in Trinity and Siskiyou counties. 2,000 w. Min and Sci Pr—Feb. 6, 1897. No. 11,007. 15 cts.

QUEBEC.

The Gold-Bearing Deposits of the Eastern Township of Quebec. Robert Chalmers. The area of this gold-bearing region is estimated at from 3,000 to 4,000 sq. miles. The writer gives facts and inferences showing the prospects to be rather encouraging, but considers knowledge and skill essential to success. 4,200 w. Can Min Rev—Feb., 1897. No. 11,333. 30 cts.

RANDSBERG.

Randsberg, a Desert Mining Town. Henry G. Tinsley. An account of the wonderful growth of this mining town, its location, prospects, discovery and value. Ill. 2,400 w. Harper's Wk—March 6, 1897. No. 11,312. 15 cts.

SMELTING.

Argentiferous Lead Smelting at Leadville. Franklin Ballou, Jr. Discusses the daily operations in a smelter. 3,000 w. Yale Sci M—Feb., 1897. No. 11,125. 30 cts.

TELLURIDES.

Concerning Tellurides. What tellurides are, how they are worked and where they occur. 2,000 w. Min Jour—Feb. 20, 1897. No. 11,316. 30 cts.

WITWATERSRAND.

Economic Features of Mining on the Witwatersrand Gold Fields. Edgar P. Rathbone. Deals with the mining of gold-bearing conglomerates on the Witwatersrand, Klerksdorp and Heidelberg goldfields collectively, as the geological deposits and conditions are the same. 3,800 w. Eng & Min Jour—Feb. 13, 1897. No. 11,010. 15 cts.

IRON AND STEEL.

ANALYSIS.

Some Present Possibilities in the Analysis of Iron and Steel. C. B. Dudley. Presidential address at meeting of Am. Chem. Soc. Survey of some of the analytical methods in use in the iron and steel industry. Only five of the constituents affecting the quality are here considered, viz.: Carbon, phosphorus, silicon, sulphur and manganese. 6,500 w. Science—Feb. 12, 1897. No. 11,049. 15 cts.

ARMOR Plate.

The Carnegie Company on Armor-Plate Costs. Extract from written statement submitted to the Senate Committee on Naval Affairs by H. C. Frick, upon the question as to what should be the price of armor-plate. 600 w. Am Mfr & Ir Wld —Feb. 12, 1897. No. 11,051. 15 cts.

BASIC Slag.

Basic Slag as a Fertilizer. F. E. Thompson. Gives experiments and results from its use in Europe, as condensed in a paper by Dr. William Frear, in the Agricultural Report of Pennsylvania for 1890. 2,400 w. Sci Am Sup—March 6, 1897. No. 11,345. 15 cts.

High Carbon Steels for Forgings. A. L. Colby. Read before the Engs.' Club of Philadelphia. The steel used in shafting, crank-pins, hammer-rods, with directions for selection of steel. 1,100 w. Ir Age—Feb. 18, 1897. No. 11,100. 15 cts.

OPEN Hearth.

The Bertrand-Thiel Open-Hearth Process. Comments on the investigations of this process made by P. C. Gilchrist, which were presented to the Cleveland Inst. of Engs. 1,500 w. Eng, Lond—Feb. 5, 1897. No. 11,026. 30 cts.

PHOSPHORUS.

Estimation of Phosphorus in the Ash of Coal and Coke. L. Campredon, in Moniteur Industriel. Gives the results of comparative tests made by the author on the ash of English coals. 700 w. Col Guard —Feb. 5, 1897. No. 11,076. 30 cts.

PIG-IRON Trade.

Review of the Pig-Iron Trade of 1896. George E. Drummond. Reviews the mar-

kets with which the Canadian iron producers have to compete and deals with the Canadian pig-iron industry in some of its bearings. Also discussion. 12,500 w. Can Min Rev—Feb., 1897. No. 11,327. 30 cts.

PIPE.

See title Cast-Iron Pipe under Municipal Engineering—Water Supply.

REVERBERATORY Furnace.

The Thwaite Steel Furnace. Illustrated description. 700 w. Eng, Lond—Feb. 12, 1897. No. 11,167. 30 cts.

TESTING of Iron and Steel.

Standardizing the Testing of Iron and Steel. P. Kreuzpointner. Showing graphically the effects of tension upon steel. Ill. 1,800 w. Second paper. Eng Mag—March, 1897. No. 11,342. 30 cts.

MINING.

DITCH Construction.

Ditch Construction in Idaho. Augustus J. Bowie. Gives details and cost of construction of Rapp's Creek ditch and flume. 2,700 w. Min & Sci Pr—Feb. 27, 1897. No. 11,347. 15 cts.

DRILL.

New Rotary Hand-Worked Rock-Drill (Liesens system). Os Derclave. Translated from Revue Universelle des Mines. Communication made to the Assn. des Ingénieurs sortis de l'Ecole de Liége (Section de Charleroi). Briefly notices the hand-drilling machines in present use, with a description of the Liesens system. Ill. 1,600 w. Col Guard—Feb. 5, 1897. No. 11,077. 30 cts.

EXPLOSIVES.

The Cost and Efficiency of Safety Explosives as compared with Gunpowder. H. Hall. A comparison between the last year gunpowder was used and the last year during which explosives have been used. 900 w. Ir & Coal Trds Rev—Feb. 19, 1897. No. 11,280. 30 cts.

MINING Engineer.

The Responsibilities of the Mining Engineer. Dr. J. B. Porter. Presents the value of the engineer from a commercial standpoint, and warns against the kinds of dishonesty especially tempting in this line of work. 2,400 w. Can Min Rev—Feb., 1897. No. 11,329. 30 cts.

MINING Law.

Remedies for Mining Damages. Laws of England as governing property acquired in mines are discussed, especially in cases requiring modification of the usual remedies. 1,800 w. Col Guard—Feb. 19, 1897. No. 11,299. 30 cts.

The Right to Vertical Support. Discusses the right of owners of the surface to absolute support of property in mining regions. 2,000 w. Col Guard—Feb. 5, 1897. No. 11,073. 30 cts.

POWER Transmission.

The Comparative Advantages and Disadvantages of Steam, Compressed Air and Electricity for Power Purposes in Coal Mining, with Special Reference to Coal-Cutting and Haulage. Charles Chetwynd Ellison. Special prize essay. Part first considers steam and compressed air, with reference to conveniences, efficiency, economy and safety. 3,700 w. Ir & Coal Trds Rev—Feb. 12, 1897. Serial. 1st part. No. 11,200. 30 cts.

PUMPING.

See "Maltby," under Electrical Engineering, Power.

TIMBERING.

Timber and Timbering. H. W. Halbaum. A lecture delivered before the Midland Counties Branch of the National Ass'n of Colliery Managers, England. The principles governing the choice of timber and the setting of props in mines; the use of iron and steel props in place of wood; the relation of the height of seam and nature of roof to strength of props; how to place props to secure the best results. 5,800 w. Col Eng—Feb., 1897. No. 11,066. 30 cts.

VENTILATION.

Furnace versus Fan Ventilation. William Clifford. Read before the Ohio Inst of Min Engs. A review of the progress made in mechanical ventilation in the past 40 years. Part first deals with the arrangements in use in early times. 1,400 w. Am Mfr & Ir Wld—Feb. 12, 1897. Serial. 1st part. No. 11,053. 15 cts.

WINDING Engines.

A Spring Coupling for Winding or Hauling Engines. Description with drawing of the invention of H. W. Hollis. 500 w. Col Guard—Feb. 12, 1897. No. 11,168. 30 cts.

MISCELLANY.

ACIDS.

Concentration of Mineral Acids. (Acides Mineraux de Haute Concentration.) Description of improved methods of concentrating sulphuric and nitric acids, with a view of reducing the loss of platinum and obtaining high concentration with greater economy. 2,500 w. La Revue Technique—Jan. 25, 1897. No. 11,410. 30 cts.

ALLOYS.

Alloys. W. C. Roberts-Austen. Fourth report of the Alloys Research Committee. Read before the Inst of Mech Engs. Deals with the present position of the research, with the copper-zinc series of alloys, with certain relations between the fusibility and strength of alloys; also gives descriptions of experiments. 5,700 w. Engng—Feb. 12, 1897. Serial. 1st part. No. 11,165. 30 cts.

ALUMINUM.

See same title under Electrical Engineering, Electro-Chemistry and Metallurgy.

BRITISH Columbia.

The West Kootenay Mines. Extracts from the report published by the Bureau of Mines of British Columbia on the Slocan, Nelson and Ainsworth mining districts in West Kootenay, written by William A. Carlyle. 1,500 w. Min & Sci Pr—Feb. 20, 1897. No. 11,236. 15 cts.

CALIFORNIA.
Outline of the Geology of California, with References to Its Mineral Deposits. Harold W. Fairbanks. This series of articles aims to awaken an interest in the study of geology as well as impart some information which shall be of value to miners. 1,400 w. Min & Sci Pr—Feb. 13, 1897. Serial. 1st part. No. 11,101. 15 cts.

DIAMONDS.
Diamonds in the Gwydir Valley (N. S. W.) L. O. B. Describes facts concerning them. 1,500 w. Aust Min Stand—Jan. 7, 1897. No. 11,001. 30 cts.

GEMS.
Precious Stones of New South Wales. J. Milne Curran. Information based on the writer's personal observations, illustrated by original photographs. 5,000 w. Aust Min Stand—Jan. 14, 1897. Serial. 1st part. No. 11,094. 30 cts.

IDAHO.
The Seven Devils' Mountains. A. F. Wuensch. Information of this district in Idaho, which promises soon to be opened by a railway. Description of mines. 2,300 w. Min Ind & Rev—Feb. 18, 1897. No. 11,181. 15 cts.

IODINE.
New Method of Extracting Iodine. (Nouvelle Methode d'Extraction de l' Iode.) This is a method of extracting iodine from the wet, unburned seaweed by treatment with a solution of caustic lime; the residue forms a very rich fertilizer. 2,000 w. La Levue Technique—Feb. 10, 1897. No. 11,413. 30 cts.

JAPAN.
The Mineral Industries of Japan. None of the mineral products except coal and copper are important, although others are found. Information of the extent to which they are developed is given. 3,800 w. Nat Ass'n of Mfrs—Circ No. 11. No. 11,176. 45 cts.

LEAD.
Halkyn Mines. E. Ashton, Jr. Describes the development of the dressing plant of this lead mine. 2,500 w. Min Jour—Feb. 20, 1897. No. 11,314. 30 cts.

MANGANESE.
The Manganese Mines of Huelva. Carlos Sundheim. Describes locality and deposits and gives analyses and amount exported. 800 w. Am Mfr & Ir Wld—Feb. 12, 1897. No. 11,052. 15 cts.

METALLURGY.
Improvements in Mining and Metallurgical Appliances During the Last Decade. E. G. Spilsbury. Notes the many and varied improvements, progress in furnace practice, steel-making, copper production, gold, silver and lead, aluminum and nickel. Pres Address at the Chicago meeting of the Am Inst of Min Engs. 6,300 w. Ir Age—Feb. 25, 1897. No. 11,208. 15 cts.

NEWFOUNDLAND.
Newfoundland as a Field for Mining Investment. Alexander Dick. Reviews the mineral deposits of the island and concludes that there are vast possibilities as a mineral producing country. 1,900 w. Can Eng—Feb., 1897. No. 11,039. 15 cts.

ORE Dressing.
Ore Dressing. H. K. Landis. The methods and apparatus employed at the zinc mines of Southwest Missouri. A description of the geological formations in which the ore is found and the different systems of concentrating as illustrated in the better plants. Ill. 1,700 w. Col Eng —Feb., 1897. No. 11,067. 30 cts.

PETROLEUM.
Graphical Record of Borings for Petroleum. (Graphique d'un Sondage à Pétrole.) A graphical chart, of which the abscissas are times and the ordinates depths, thus giving ocular demonstration of the rates at which various portions of the work have progressed. 1,500 w. La Revue Technique—Feb. 10, 1897. No. 11,414. 30 cts.

TASMANIA.
Tasmania as a Mining Field. C. C. Longbridge. Information gained from the report of the Sec for Mines in Tasmania, calling attention to mines likely to prove of commercial value. 1,700 w. Min Jour—Feb. 20, 1897. No. 11,317. 30 cts.

TESTING.
See same title under Mechanical Engineering, Miscellany.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

ACETYLENE.
Apparatus for Lighting with Acetylene. Illustrated description of three new pieces of apparatus, designed both for the production of acetylene and for lighting therewith. Camp's and Mareschal's gas generators, and the Morison Lamp. From Revue Industrielle. 1,200 w. Sci Am Sup—Feb. 27, 1897. No. 11,214. 15 cts.

ACETYLENE.
The Storage of Calcium Carbide and Acetylene. Editorial from London Chemical Trade Journal. Gives classification and reviews the position showing that calcium carbide is safe, compressed acetylene gas practically so, while liquid acetylene requires care in handling. 1,300 w Pro Age—March 1, 1897. No. 11,322. 15 cts.

ASCENSION-PIPES.
Stoppages in Ascension-Pipes. Norton H. Humphrys. Considerations offered in the hope of aiding those having this trouble to contend with. 3,500 w. Jour Gas Lgt—Feb. 23, 1897. No. 11,348. 30 cts.

ELECTRICITY.
Some Facts Relating to Gas and Electricity. J. F. Seaman. Remarks the early effect of electricity upon gas stocks, and compares the central station and gas plant; storage battery and gas holder,

and other related matters. 2,200 w. Am Gas Lgt Journal—Feb. 15, 1897. No. 11,034. 15 cts.

Some Facts Relating to Gas and Electricity. Discussion of Mr. Seaman's paper at the annual meeting of the Ohio Gas Light Association. 4,500 w. Am Gas Lgt Jour—Feb. 22, 1897. No. 11,195. 15 cts.

EXPLOSION.

A Curious Gas Explosion. Irvin Butterworth. Read at meeting of Ohio Gas Lgt. Asso. Describes the circumstances of the explosion, which occurred May 12, 1896, at the Ohio Institution for Feeble Minded Youth, two miles from Columbus, O. 2,400 w. Am Gas Lgt Jour—Feb. 15, 1897. No. 10,035. 15 cts.

FUEL.

See Gas, under Electrical Engineering—Miscellany.

GAS Industry.

Inaugural Address of J. W. Helps. Read at meting of the Southern District Association of Gas Engs. and Mangrs., London. General review of topics of interest in the gas industry, especially regarding the establishment of experimental works, handling of coal, &c. 7,000 w. Gas Wld—Feb. 13, 1897. No. 11,158. 30 cts.

Inaugural Address of Mr. C. D. Lamson before New England Association of Gas Engineers. A review of the past year, considering most of the subjects of interest in the gas industry. 8,400 w. Am Gas Lgt Jour—March 1, 1897. No. 11,260. 15 cts.

GAS Manufacture.

Address by Prof. Charles F. Chandler, of Columbia College. Delivered at Madison Sq. Garden, Feb. 4. The popular fallacies which are held in regard to gas and gas companies. 4,200 w. Pro Age Sup—March, 1897. No. 11,323. 15 cts.

GASSING.

"Gassing." Its Prevention and Cure. Review of two papers bearing on gas poisoning which were read and discussed at the Liverpool Section of the Soc of Chem Ind. The papers were by Arthur Carey and Douglas Herman. 2,000 w. Jour of Gas Lgt—Feb. 9, 1897. No. 11,186. 30 cts.

HYDROCARBONS.

The Decomposition of Hydrocarbons by Heat. Dr. F. Haber and Herr H. Oechelhaeuser. Abstract translation of paper recently published in the "Journal für Gasbeleuchtung." The apparatus used is described with special methods of gas analysis devised for the work and experiments. 1,200 w. Jour Gas Lgt. Feb. 16, 1897. Serial. 1st part. No. 11,268. 30 cts.

ILLUMINATION.

Artificial Illumination. G. P. Lewis. Abstract of a lecture, briefly reviewing progress, considering thermal and lighting efficiencies, illuminating power and illuminating effect, &c. 1,500 w. Jour Gas Lgt —Feb. 16, 1897. No. 11,267. 30 cts.

ILLUMINATION.

The Development of Light from Gas Flames. Vivian B. Lewes. Paper contributed to the N. Y. Gas Exposition. Arguments in favor of the acetylene theory of luminosity. 6,000 w. Gas Wld—Feb. 6, 1897. No. 11,079. 30 cts.

PHOTOMETRY.

Address by Dr. Henry Morton, of Stevens Institute of Technology. Delivered at Madison Sq. Garden, Feb. 4. The Measurement of Light. 2,800 w. Pro Age Sup—March, 1897. No. 11,324. 15 cts.

SULPHUR.

On the Measurement of Sulphurous and Sulphuric Acids in the Products of Combustion of Illuminating Gases. M. Dermstedt and C. Ahrens, in Zeitschrift für Analytische Chemie. (Review of an article by Uno Collan, continuing researches and describing experiments made.) 2,000 w. Pro Age—Feb. 15, 1897. No. 11,118. 15 cts.

WELSBACH.

Public Lighting by the Welsbach System in Paris. M. Maréchal. Abstract of an article contributed to "Genie Civil," with comments from the "Journal de l'Eclairage au Gaz," giving a French gas engineering view of the requirements and possibilities of street lighting. 2,500 w. Jour Gas Lgt—Feb. 16, 1897. No. 11,265. 30 cts.

SEWERAGE.

CALCUTTA.

Calcutta Drainage Scheme. A brief outline of the history of the drainage, with sketch. 1,400 w. Ind Engng—Jan. 23, 1897. No. 11,264. 45 cts.

PUMPING.

Sewage Elevator. (Elevateur Hydro-Pneumatique.) Illustrated description of the Adams system of elevating and discharging sewage by automatic siphons operated by compressed air. 2,500 w. La Revue Technique—Feb. 10, 1897. No. 11,417. 30 cts.

TUNNEL.

The Milwaukee River Flushing Tunnel. Lawrence Fitch. Describes the successful plan brought forth by Mr. Benzenberg for overcoming the unhealthful condition of this stream. 1,100 w Yale Sci M—Feb., 1897. No. 11,124. 30 cts.

STREETS AND PAVEMENTS.

BRICK.

An Investigation of the Benefit of Structure on the Wearing Power of Paving Brick. Edward Orton, Jr. Gives results of investigations authorized by the Nat. Brick Mfrs.' Assn. Discussion follows. 4,000 w. Brick—Feb., 1897. No. 11,046. 15 cts.

Paving Brick for Country Roads. Thomas S. McClanahan. Discusses the need of good country roads, and the construction of brick roads. 1,800 w. Brick—Feb., 1897. No. 11,044. 15 cts.

Report of the Commission on Paving-Brick Tests. Edward Orton, Jr. Reports of tests by rattling, absorption, cross-

breaking, crushing, hardness, and specific gravity. 6,300 w. Brick—Feb., 1897. No. 11,047. 15 cts.

Standard Specifications for Paving-Brick Tests. Report submitted to the National Brick Mfrs.' Assn. by the committee appointed to investigate the question. 6,000 w. Munic Engng—March, 1897. No. 11,289. 30 cts.

SIDEWALKS.

Traveling Sidewalks and Their Advantages for Large Cities. (Stufenbahn und ihre Bedentung für den Massenverkehr in Gross Städten.) A description of the traveling sidewalk at the Berlin exhibition, with data as to power consumed and carrying capacity. 1,200 w. Glaser's Annalen—Feb. 1, 1897. No. 11,419. 30 cts.

SNOW Removal.

A Snow-Melting Machine. Illustrated description of a machine recently tested in New York. It is naphtha burning, and can be drawn by horses or propel itself. The melting capacity is estimated at about a cubic yard per minute. 900 w. Sci Am—Feb. 27, 1897. No. 11,211. 15 cts.

STREET Esthetics.

The Positive Value of Quiet and Beautiful Streets. J. W. Howard. Showing the elements that contribute to the value of city thoroughfares. Ill. 2,500 w. Eng Mag—March, 1897. No. 11,338. 30 cts.

STREETS.

Cross Sections of European Streets.—Robert Grimshaw. Shows the usage and provision made as regards street width and profile. Ill. 1,700 w. Munic Engng—March, 1897. No. 11,287. 30 cts.

WATER SUPPLY.

AIR LIFT Pumps.

Air Lift Pumps. Tests of Pohle Air Lift Pumps at the Rockford (Ill.) Water Works. Charles C. Stowell, in a paper read before the Ill. Soc. of Engs. & Survs. Description of trials and experiments continued over a period of nearly two years. Ill. 1,600 w. Eng News—March 4, 1897. No. 11,357. 15 cts.

AQUEDUCT.

Nashua Aqueduct; Boston Water Supply. A comprehensive description of the various parts of the scheme, with two-page engraving. 2,500 w. Eng News—Feb. 25, 1897. No. 11,237. 15 cts.

CAST Iron Pipe.

The Early History of Cast Iron Pipe. Extract from paper by Jesse Garrett, read at meeting of New England Water Works Assn. in 1896. Earliest accounts of cast iron and its first use for pipe. 1,500 w. Bul of Am Ir & St Assn—March 1, 1897. No. 11,256. 15 cts.

DENVER.

Notes on the Water Supply of Denver, Col. Information concerning some of the interesting parts of the system, with cuts of the new masonry dam. 1,800 w. Eng News—Feb. 25, 1897. No. 11,241. 15 cts.

FILTRATION.

An Improved Method of Filtration. Describes a system in operation in several cities of Germany that should be of interest to those struggling with the problem of purifying river water on a large scale for household and manufacturing purposes. 1,400 w. Cons Repts—Feb., 1897. No. 10,975. 45 cts.

LONDON.

London Water Supply. Editorial presenting the undesirability of intrusting the London County Council with the water supply. 1,500 w. Engng—Feb. 19, 1897. No. 11,303. 30 cts.

The Water Supply of London. W. H. Dickinson. A statement of the existing conditions and favoring the transfer of the undertakings into the hands of public authority. 9,000 w. Contemporary Rev—Feb., 1897. No. 11,002. 45 cts.

Water Supply of London and Other Large Towns. An examination of municipal water supplies as to quantity, purity, cost, &c. 2,400 w. Jour Gas Lgt—Feb. 16, 1897. No. 11,270. 30 cts.

MUNICIPAL Water Works.

The Terms of Purchase of Municipal Water Undertakings. List, prepared by order of London County Council, of the county boroughs in which the water works have been purchased, with the date, and remarks briefly setting forth the conditions and terms. 4,300 w. Jour of Gas Lgt—Feb. 16, 1897. No. 11,269. 30 cts.

ORGANISMS.

Detection of Organisms Affecting the Taste and Smell of Water by the Microscope. Abstract of an article in the Stevens Indicator by Dr. Albert R. Leeds explaining how examinations can easily be made. 1,000 w. Eng Rec—Feb. 20, 1897. No. 11,150. 15 cts.

PIPE.

Lead Pipe versus Iron. See Architecture, Plumbing and Gas Fitting.

RECORDS.

Prize Water-Works Blanks and Records. Information sifted from replies received in a prize competition, aiming to provide a method of keeping the accounts that is better than any one method now in use. 2,000 w. Munic Engng—March, 1897. No. 11,288. 30 cts.

RESERVOIR.

Reservoir No. 5; Boston Water Works. Illustrated description of interesting features of the work on this reservoir, with other information. 1,400 w. Eng News—March 4, 1897. No. 11,352. 15 cts.

Drainage Areas, Storage Capacity, and Compensation Water Discharged from Catchment Reservoirs. W. Watts. An epitome of paper read before the British Assn. of Water-Works Engs., with discussion. The difficulties met with by water authorities. 7,500 w. Jour of Gas Lgt—Feb. 23, 1897. No. 11,349. 30 cts.

SPRINGS.

Tracing the Water Supply of Springs. (Untersuchung einer Quelle in Herzegowinischen Karste auf ihren Ursprung.) An account of methods of tracing sources of water by salt, coloring matter, etc., as

compared with topographical investigation. 2,000 w. Zeitschr. d. Oesterr. Ing. u. Arch. Vereines—Jan. 29, 1897. No. 11,424. 15 cts.

WATER Tower.

A Steel Water Tower. Illustrated description of tower at Paris, Ill., a place of 12,000 inhabitants. 700 w. Eng Rec—Feb. 27, 1897. No. 11,263. 15 cts.

MISCELLANY.

FIRE Alarm.

See same title under Electrical Engng—Miscellany.

MUNICIPAL Plants.

See same title under Electrical Engineering—Light.

RESERVOIRS.

Diagrams for Estimating the Required Storage Capacities for River Drainage Areas. F. S. Bailey. Diagram useful for estimating the amount of water which a drainage area or reservoir will supply in extremely dry seasons. 400 w. Eng News—March 4, 1897. No. 11,358. 15 cts.

SANITATION.

German Maxims on School Sanitation. Reported by William Paul Gerhard. The result of several conferences held by a number of prominent German physicians, architects, sanitary engineers and school teachers. 1,800 w. Arch & Build—Feb. 6, 1897. No. 10,976. 15 cts.

The Sanitary Supervision of Shelters for the Homeless. F. J. Waldo. Abstract of a paper read before the Sanitary Inst., showing the necessity of bringing those places under the control of the local authorities. 1,200 w. San Rec—Feb. 19, 1897. No. 11,310. 30 cts.

TUNNEL.

The Design and Construction of a Small Steel Cylindrical Tunnel. H. D. Woods. Illustrated detailed description. 800 w. Eng Rec—Feb. 20, 1897. No. 11,151. 15 cts.

RAILROAD AFFAIRS.

NEW CONSTRUCTION.

JAPAN.

An Era of Railroad Building. A few facts in relation to the present railway system in Japan, with brief forecast of its possibilities. 1,100 w. Nat Ass'n of Mfrs. Circ No. 11. No. 11,173. 45 cts.

LIGHT Railway.

The Barsi 2 ft. 6 in. Gage Light Railway. Everard R. Calthrop. The theory of the narrow gage light railway is explained; the history of this railway given, with discussion of traffic, rolling stock, permanent way and general information. Followed by discussion. 12,500 w. Jour Soc of Arts—Feb. 19, 1897. No. 11,318. 30 cts.

MONORAIL.

A Single-Rail Railway. Illustrated description of a monorail system, designed by Mr. Cailletet, possessing the conditions demanded for limited traffic in thinly populated districts, though not applicable to steam or other power traction. 1,500 w. Engng—Feb. 5, 1897. Serial. 1st part. No. 11,022. 30 cts.

RAILROAD Construction.

Mistakes and Improvements in Railroad Construction. George H. Paine. Showing the causes of the inferiority of American railway track and the considerations that must govern in improving it. 4,300 w. Eng Mag—March, 1897. No. 11,337. 30 cts.

SIBERIAN Railway.

Siberian Railroad Extension in China. The details of the arrangement for constructing and working a railway within Chinese territory. Also "Estimates of Siberian Railroad Traffic," and "Siberia as a Grain Exporting Country." 4,400 w. Cons Repts—Feb., 1897. No. 11,107. 45 cts.

TRACK Elevation.

Erection of the Park Avenue Viaduct, New York. Part first describes and illustrates the false work supporting temporary tracks and new centre girders. 1,500 w. Eng Rec—Feb. 27, 1897. Serial, 1st part. No. 11,262. 15 cts.

EQUIPMENT AND EQUIPMENT MAINTENANCE.

AXLES.

A New Method of Dressing Axles. See Car Wheels, below.

Divided Axles for Railways. (Ueber eine getheilte Eisenbahnachse.) A brief description of experiments with axles divided in the middle, with a loose sleeve coupling, to permit independent action of the wheels. 900 w. Glaser's Annalen—Feb. 1, 1897. No. 11,420. 30 cts.

BEARING.

A Roller Centre Bearing. Illustrated description of a centre bearing, designed to afford a slight amount of side motion, recently patented by Edward Cliff. 500 w. RR Car Jour—Feb., 1897. No. 10,991. 15 cts.

CAR.

A Private Car for the President of the United States. A project to construct a special car of the most approved design and from the best materials, to be subscribed for and built by the car-building and allied industries and presented to the nation for the use of the President. Names of the advisory committee are given and expressions of approval. 2,700 w. RR. Car Jour—Feb., 1897. No. 10,987. 15 cts.

Combination Car; B. & O. RR. Illustrated description of a combination baggage and passenger car recently built and put into service. 1,500 w. RR. Car Jour—Feb., 1897. No. 10,989. 15 cts.

Railroad Car Design. Archer Richards. Read before the Assn of American Draftsmen. A study of design and the various types of ornamentation. 2,500 w. RR. Car Jour—Feb., 1897. No. 10,990. 15 cts.

Steel Hopper Cars—Pittsburg, Bessemer and Lake Erie Railroads. Illustrations and

description, showing the method of construction which is to be employed in several hundred new steel cars. 1,300 w. Ry Rev—Feb. 20, 1897. No. 11,199. 15 cts.

CAR-WHEELS.

A New Method of Dressing Car Wheels, Axles, Etc. R. Atkinson. Read before the Canadian Soc. of Civ. Engs. Describes the working of iron in the cold state by means of machinery, and specially describes the Sibbald machine and process with trials. 2,000 w. Eng News—Feb. 25, 1897. No. 11,240. 15 cts.

Correct Gaging in Mounting Car-Wheels. Facts brought out in the paper presented by Mr. George Tatnall at meeting of N. Y. RR. Club, with editorial comment. 1,500 w. RR Gaz—Feb. 26, 1897. No. 11,244. 15 cts.

COUPLERS.

Defects in M. C. B. Couplers. Editorial comment on article by M. J. Lorraine considering the contour lines of this coupler. 1,300 w. Ry Rev—Feb. 13, 1897. No. 11,087. 15 cts.

ENGINE.

See Locomotive, below.

LOCOMOTIVE.

Engines of the London, Chatham and Dover Railway. W. B. Paley. Illustrated description. This was the first line to use bogie express engines south of London. 1,800 w. Ry Wld—Feb., 1897. No. 11,090. 30 cts.

Locomotives at the Nuremberg Exhibition. (Die Lokomotiven auf der II. Bayrischen Landesausstellung in Nürnberg, 1896.) Description with numerous details of the important compound and other locomotives of the leading German builders. 2 articles—20,000 w. Zeitschr d Vereines Deutscher Ingenieure—Jan. 23 & Feb. 13, 1897. No. 11,402. 45 cts.

Smokestacks and Front-Ends for Locomotives Burning Lignite and Wood Fuel. Illustrated description of stacks used on the Union Pacific, made necessary by the kind of fuel used. 1,300 w. Eng News—March 4, 1897. No. 11,359. 15 cts.

Twelve-Wheel Compound Locomotive—Northern Pacific Railway. Dimensions, with description of an interesting design recently built by the Schenectady Locomotive Works for the Northern Pacific. 1,500 w. Ry Rev—Feb. 20, 1897. No. 11,197. 15 cts.

PLATFORM.

New Trojan Passenger Equipment. Brief description, with sections of buffer, of a recently introduced centre stem platform, with some novel features. 400 w. Ry Age—Feb. 19, 1897. No. 11,190. 15 cts.

SLEEPING Car.

An English Sleeping Car. Illustrated description of cars recently put upon the Northeastern Railway of England. Each passenger is given a stateroom. 3,000 w. RR Car Jour—Feb., 1897. No. 10,988. 15 cts.

SNOW-Flanger.

Snow-Flanger Operated by Air—Lake Shore and Michigan Southern Railway. Oscar Antz. Illustrated detailed description. 1,500 w. Am Eng & RR Jour—March, 1897. No. 11,254. 30 cts.

STEEL Cars.

Recent Designs for Steel Cars, Universal Construction Company, Chicago, Ill. Illustrated description of the improved Pennock car. 1,200 w. Eng News—March 4, 1897. No. 11,354. 15 cts.

UNDERFRAMES.

The Maintenance of Iron and Wooden Underframes of Freight Cars in France. M. L. Tolmar. Part first classifies the cars, giving general description and maintenance of the general types. Ill. 2,700 w. Am Eng & R R Jour—March, 1897. Serial. 1st part. No. 11,253. 30 cts.

MAINTENANCE OF WAY AND STRUCTURES.

BRIDGES.

Different Methods of Numbering Bridges. Should All Waterways Be Numbered? Report of committee to the Convention of Ry. Supts., with discussion. 7,500 w. Pro of Assn of Ry Supts—Oct., 1896. No. 11,058. 45 cts.

The Mechanical Action and Resultant Effects of Motive Power at High Speeds on Bridges. Report of committee to Convention of Ry. Supts of Bridges and Buildings, with brief discussion. 1,000 w. Pro of Assn of Ry Supts—Oct., 1896. No. 11,063. 45 cts.

DEFLECTION.

See same title under Civil Engineering, Miscellany.

DRAWBRIDGE.

Methods of Locking Drawbridge Ends, and Under This Head Include Locking of Turn-Tables. Reports to Convention of Ry. Supts. of Bridges and Buildings, with diagrams and discussion. 3,300 w. Pro of Assn of Ry Supts—Oct., 1896. No. 11,059. 45 cts.

Opening of the N. Y. C. Four-Track Drawbridge and Viaduct in New York City. Illustrated description of this interesting work. 2,000 w. Sci Am—Feb. 27, 1897. No. 11,209. 15 cts.

FILL.

See same title under Civil Engineering, Miscellany.

PILE-DRIVER.

Best and Most Economical Railway Track Pile-Driver. Report of G. W. Hinman to the Convention of Ry. Supts. of Bridges and Buildings, with discussion. 2,400 w. Pro of Assn of Ry Supts—Oct., 1896. No. 11,064. 45 cts.

PLATE GIRDER.

See same title under Civil Engineering, Bridges.

RAILS.

Influence of Impact Upon Rails. (Zur Schienenstossfrage.) An investigation by Engineer Trautweiler, of Strasburg, upon the "hammer blow" action and pound upon rail joints. 5,000 w. Schweizerische Bauzeitung—Jan. 23, 1897. No. 11,445. 15 cts.

The Creep of Rails. (Ueber das Wandern der Schienen bei Eisenbahn-Geleisen.) An investigation into the causes of the creep of rails, with especial reference to the action of the locomotives in causing unequal creep. 2 articles, 10,000 w. 1 plate. Zeitschr Oesterr Ing u Arch Vereines—Jan. 22 and 29, 1897. No. 11,422. 30 cts.

RAILS and Splice Bars.

Specifications and Sections for Steel Rails and Angle Splice Bars, New York Central and Hudson River Railroad. Short description of track adopted, with the specification for rails and splice bars, recently adopted. 2,500 w. Am Eng & R R Jour—March, 1897. No. 11,252. 30 cts.

STATION.

Grand Trunk Railway Improvements. Drawings and description of some of the passenger stations and other important buildings erected during the past season. 1,700 w. Can Eng—Feb., 1897. No. 11,040. 15 cts.

Local Stations for Small Towns and Villages, Giving Plans of Buildings and Platforms. Report of comittee to convention of Ry. Supts., with numerous plans and discussion. 4,500 w. Pro of Assn of Ry Supts—Oct., 1896. No. 11,061. 45 cts.

The Revised Grand Central Station, New York City. Illustrated description of the extensive changes proposed, which will greatly increase the facilities for handling the immense business carried on. 1,800 w. R R Gaz—Feb. 19, 1897. No. 11,135. 15 cts.

TANKS.

Tanks, Size, Style and Details of Construction, Including Frost-Proof Protection to Tank and Pipes. Report of committee to Convention of Ry. Supts. of Bridges and Buildings, with discussion. 2,800 w. Pro of Assn of Ry Supts—Oct., 1896. No. 11,062. 45 cts.

TRACK Circuit.

Observations on the Track Circuit from an English Standpoint. Arthur H. Johnson. A short description of the principles upon which such a circuit is operated. 1,500 w. R R Gaz—March 5, 1897. No. 11,360. 15 cts.

TRACK Elevation.

The Elevated Tracks of the New York Central Railroad in New York City. A series of views, with description of the work of raising the tracks to an elevated steel structure, and the various expedients which were resorted to in keeping the traffic and the new construction going at the same time. It is pronounced one of the most brilliant engineering feats on record. 2,800 w. Sci Am Sup—Feb. 20, 1897. No. 11,104. 15 cts.

TRESTLES.

Methods and Special Appliances for Building Temporary Trestles Over Washouts and Burnouts. Discussion at sixth annual convention of the Assn of Ry Supts of Bridges and Buildings. 2,800 w. Pro of Assn of Ry Supts—Oct., 1896. No. 11,055. 45 cts.

Protection of Trestles from Fire, Including Methods of Construction. Report of G. W. Hinman to the Convention of Ry Supts, with design and discussion. 1,500 w. Pro of Assn of Ry Supts—Oct., 1896. No. 11,060. 45 cts.

See Timber under Civil Engineering, Bridges.

VIADUCT.

The Coldremick Viaduct Disaster. Illustrated description of an accident on the viaduct of the Great Western Railway, England, while work was in progress for widening the line. 1,500 w. Eng, Lond—Feb. 19, 1897. No. 11,301. 30 cts.

SIGNALLING.

GRADE Crossing.

The Protection of Level Crossings. Notes on the minimizing of danger when a railway crosse.. a road or footpath. Confined to the practice in England. 3,500 w. Engng—Feb. 5, 1897. No. 11,021. 30 cts.

INTERLOCKING.

Electric Interlocking the Block and Mechanical Signals on Railways. F. T. Hollins. Read at London Inst of Elec Engs. Briefly describes the systems of electric interlocking in practical use, dealing more in detail with the Sykes system. 4,500 w. Elec Eng, Lond—Jan. 29, 1897. Serial. First part. No. 10,980. 30 cts.

TRANSPORTATION.

CAR-FERRY.

Car Ferries of the Great Lakes of America. Illustrated description. 2,400 w. Eng, Lond. Feb. 5, 1897. No. 11,027. 30 cts.

EARNINGS.

Net Railway Earnings in 1896. A comparison with the previous year, with reasons for the less favorable showing, and tabulated statements. 1,500 w. Bradstreet's—Feb. 20, 1897. No. 11,144. 15 cts.

January's Poor Railroad Earnings. Table of gross earnings for 114 roads for Jan., 1897, comparing with a year ago and other statistics. 1,500 w. Bradstreet's—Feb. 13, 1897. No. 11,008. 15 cts.

EMPTY-CAR Mileage.

Should Mileage Be Paid on Empty-Car Movements? W. E. Beecham. From Ry Equipment Register. Discusses the return movements of empty cars, and gives what the writer considers the common sense way of disposing of the car. 1,800 w. Ry Rev—Feb. 13, 1897. No. 11,085. 15 cts.

FAST Running.

A New Record for Long-Distance Running. An interesting account of a fast run made from Chicago to Denver over the C., B. & Q. R. R. at an average speed of 54.27 miles per hour, with running time at an average of 57.53 miles. 1,700 w. R. R. Gaz—Feb. 26, 1897. No. 11,242. 15 cts.

INTERSTATE Commerce Act.

A Decade in Federal Railway Regulation. H. T. Newcomb. Abstract of paper

read at meeting of Am Economic Assn. Discusses the effect of the Interstate Commerce law. 1,000 w. Ry Rev—Feb. 27, 1897. No. 11,307. 15 cts.

Is the Interstate Commerce Act a Failure? From the Chicago Herald. Views of various officials. 1,400 w. Ry Rev—Feb. 13, 1897. No. 11,084. 15 cts.

RATES.

Unlawful Rates in Grain Transportation. The finding of the Interstate Commerce Commission in the alleged unlawful rates made by the Chicago Great Western Ry, with editorial comment. 3,000 w. Ry Rev—Feb. 13, 1897. No. 11,086. 15 cts.

TERMINAL Charges.

Terminal Charges. Editorial comment on paper of R. Price Williams, read before the Royal Statistical Society. 2,200 w. Engng—Feb. 19, 1897. No. 11,302. 30 cts.

MISCELLANY.

ACCIDENTS.

Train Accidents in 1896. Tabular summary, with comments. 800 w. R R Gaz—Feb. 19, 1897. No. 11,137. 15 cts.

Train Accidents in the United States in January. Classified report of the more important accidents, with summary. 3,300 w. R R Gaz—Feb. 26, 1897. No. 11,243. 15 cts.

EDUCATION.

The Profession of the Railway and a Suggested Course of Training Therefor. George B. Leighton. Read before the N. Y. RR. Club. The author's ideas are presented and the paper followed by a lengthy discussion. 3,300 w. N. Y. RR Club—Jan. 21, 1897. No. 11,088. 45 cts.

EUROPEAN Railways.

European vs. American Railways. A comparison of advantages as shown in the report of Consul Monaghan, of Chemnitz. 700 w. Bradstreet's—Feb. 27, 1897. No. 11,251. 15 cts.

EXPOSITIONS.

Railway Exhibits at Berlin, Budapest and Nuremberg, 1896. (Die Eisenbahn-Fahrbetreibsmitte auf den Ausstellungen zu Berlin, Budapest und Nürnberg, 1896.) A critical examination, by H. von Littrow, of the locomotives exhibited, with illustrations of details. 10,000 w. 2 plates. Zeitschr d Oesterr Ing u Arch Vereines—Feb. 5, 1897. No. 11,426. 30 cts.

RAILWAY LEGISLATION.

The Railway Problem. I. The Legislative Solution. Lloyd Bryce. II. A Mercantile View. James J. Wait. A review of the past and present condition of railroads is given by Mr. Bryce, with presentation of the difficulties, and the remedies suggested. Mr. Wait recommends educating the people to be honest with railroads, discusses existing conditions and suggests solution of the problem. 7,500 w. N Am Rev—March, 1897. No. 11,284. 45 cts.

STATE Ownership.

The Leasing of the Brazil State Railways. Statement of the wretched management of the government railways, and the decision to invite tenders from capitalists for the privilege of working them. 900 w. Trans—Feb. 12, 1897. No. 11,182. 30 cts.

SUBURBAN Traffic.

Electricity for Suburban Traffic. Remarks on Mr. Wallace's paper and the discussion that followed. 1,600 w. R R Gaz—Feb. 12, 1897. No. 11,015. 15 cts.

TAXATION.

Taxation of Railroads. Editorial discussion of the report of the special New Jersey Tax Commission. 2,000 w. R R Gaz—Feb. 12, 1897. No. 11,014. 15 cts.

TESTING.

The Chicago and Northwestern Testing Plant. E. M. Herr. Abstract of paper presented at the W. Ry Club. Description of tests. 2,800 w. R R Gaz—Feb. 19, 1897. No. 11,136. 15 cts.

WATER Supply.

Water Supply Stations for Locomotives. C. F. Street. From a discussion before the Western Ry Club. Discusses the use of the gas engine for pumping. 1,300 w. Ry Rev—Feb. 20, 1897. No. 11,198. 15 cts.

STREET AND ELECTRIC RAILWAYS.

GENERAL CONSTRUCTION.

ATHENS, Ga.

The Street Railway at Athens, Ga. Illustrated description of an interesting plant in which water power replaces steam. 900 w. St Ry Rev—Feb. 15, 1897. No. 11,116. 30 cts.

BILBAO.

Electric Tramway at Bilbao. (Elektrische Strassenbahn in Bilbao.) The line runs on both sides of the river Nervion from Bilbao to the harbor on the Bay of Biscay, a distance of about 9 miles. 1,200 w. Elektrotechnische Zeitschrift—Jan. 21, 1897. No. 11,432. 15 cts.

BUDAPEST.

The Budapest Electric Railway. Brief review of the Hungarian capital, especially its street railways, giving an account of the construction of the underground railway and its operation. Ill. 2,500 w. Trans—Jan. 29, 1897. No. 10,978. 30 cts.

ELEVATED Roads.

Some New Street and Electric Elevated Railroads in Europe. Condensed information of the electric line in Vienna, the Jungfrau, Edinburgh cable roads, Budapest Intramural railroad, Liverpool overhead railway and improvements in the electric roads of Lyons. 1,800 w. RR. Gaz—March 5, 1897. No. 11,361. 15 cts.

OVERHEAD Railway.

Extension of the Liverpool Overhead Railway. Illustrated detailed description.

2,200 w. Elec Rev, Lond—Jan. 29, 1897. No. 10,983. 30 cts.

SUBWAY.

Lease of the Boston Subway. The two bills introduced in the Legislature are explained, with a statement of the views of the commission, and the terms of the lease as finally adopted. 2,000 w. RR. Gaz—March 5, 1897. No. 11,362. 15 cts.

VERSAILLES.

Electric Tramways at Versailles. Illustrated detailed description. 1,000 w. Ry Wld—Feb., 1897. No. 11,092. 30 cts.

Electric Tramway at Versailles. (Les Tramways Electriques de Versailles.) Description, with map, of the local overhead trolley line recently opened at Versailles. 3,000 w. La Revue Technique—Feb. 10, 1897. No. 11,416. 30 cts.

VIENNA.

Electric Traction in Vienna. Illustrated description of the "Transversal" electric line of the Vienna Tramways Company. 1,000 w. Ry Wld—Feb., 1897. No. 11,091. 30 cts.

EQUIPMENT.

PLATFORM Buffer.

A Continuous Platform Buffer for Elevated Cars. Illustrated description of a new type of continuous platform buffer and automatic coupler, which has been in service on the Yonkers Branch of the New York Central, and is designed specially to meet the conditions imposed by a service on which the curves are very sharp. 600 w. RR. Gaz—March 5, 1897. No. 11,364. 15 cts.

LINE.

CONCRETE.

Concrete Work in Track Construction. Data on the cost of trench work in Minneapolis, with illustrations. 1,200 w. St Ry Rev—Feb. 15, 1897. No. 11,112. 30 cts.

ELECTRIC Conduit.

New Electric Conduit Lines in New York. Illustrated description of proposed work for the extension of this system, with editorial. 1,600 w. RR. Gaz—March 5, 1897. No. 11,363. 15 cts.

UNDERGROUND Trolley.

Underground Trolley, Cirla System. (System Cirla für unterirdische Stromzuführung bei elektrischen Strassenbahnen.) Illustrated description of an Italian electric tramway system with underground conductor and successive surface contacts. 1,000 w. Elektrotechnische Zeitschrift—Jan. 14, 1897. No. 11,429. 15 cts.

POWER.

COMPRESSED Air.

The Hardie Compressed Air Motors. Herman Haupt. An effort to answer some prominent objections. Also test of a compressed air reservoir taken from a Hardie motor after having been in use two years. 3,500 w. Sci Am Sup—Feb. 20, 1897. No. 11,105. 15 cts.

ELECTRIC Traction.

Electricity on the Manhattan Elevated Railways. The probability of electric propulsion on the elevated railways is discussed. 1,600 w. Elec Wld—Feb. 27, 1897. No. 11,258. 15 cts.

Practice in Electric Railway Power Distribution in Eastern Massachusetts. Deals with work actually done on some of the lines, with nearly every variety of problem in electric feeding and the solutions adopted. 4,000 w. St Ry Rev—Feb. 15, 1897. No. 11,114. 30 cts.

WATER-POWER and Electric Traction.

A Water Power Developed for Electric Railway. Albert Phenis. A description of the plant at Athens, Ga. 1,300 w. Mfrs Rec—Feb. 12, 1897. No. 11,004. 15 cts.

MISCELLANY.

ELECTRIC Railway Operation.

Comparative Economy in Electric Railway Operation. Charles H. Davis. Claiming that true economy lies less in the saving of coal than in the saving of wear and labor. 3,300 w. Eng Mag—March, 1897. No. 11,339. 30 cts.

FARES.

The Reduction in Street Car Fares. It is asserted that not only has the price of carfares been reduced, but that no other article in common use has been as greatly reduced. Specific cases show a surprising increase of service, without increase of compensation. Diagrams show the extension since 1887. 2,800 w. St Ry Rev—Feb. 15, 1897. No. 11,113. 30 cts.

OPERATING Expenses.

Operating Expenses of Connecticut Roads in 1896. Information from the annual report of the Railroad Commissioners of Connecticut regarding the earnings and expenses of the street railways. 1,500 w. St Ry Rev—Feb. 15, 1897. No. 11,115. 30 cts.

RAPID Transit.

Rapid Transit. The Report of Through Train Service Across the Brooklyn Bridge. Extracts from the report and drawings, showing the plans proposed. 5,800 w. Eng News—Feb. 18, 1897. No. 11,131. 15 cts.

Rapid Transit. Report of the committee of experts favorable to the idea of Brooklyn elevated and trolley cars crossing the bridge. Plans for the surface cars and L trains are given. 800 w. Elec—Feb. 10, 1897. No. 10,992. 15 cts.

REPAIRS.

Repair of Electric Railway Machinery. Describes methods and appliances for comparing two motors in order to determine their adaptability for mutual operation. 1,700 w. Am Elect'n—Feb., 1897. No. 11,223. 15 cts.

TESTING Wagon.

Testing Wagon of the Electrical Department of the City of Munich. (Der Kabelmesswagen der städtischen Elektricitätswerke in München.) An illustrated description of a portable testing apparatus, forming a complete laboratory on wheels. 1,500 w. Elektrotechnische Zeitschrift—Jan. 21, 1897. No. 11,431. 15 cts.

BOOKS OF THE MONTH

Bell, Louis, Ph. D. Electrical Power Transmission; A Practical Treatise for Practical Men. The W. J. Johnston Company, New York. 1897. Cloth, $2.50.

The author sets forth in the preface his intent of covering present practice, in such a way that "the man, engineer or not, who desires to know what can be accomplished by electrical power transmission, and by what processes the work is planned and carried out," may acquire this knowledge readily. The extreme technical side of the subject is therefore not allowed to obscure the practical side. Typical apparatus is described, rather than special and mutable forms. As a preliminary to the discussion of electric transmission, all other modes are discussed and comparisons are made which indicate the legitimate use of each. The modes of dederiving formulæ which are in common use are very little considered; but the use and applications of these rules are clearly set forth. The book is handsomely printed and well illustrated.

BOOKS RECEIVED.

The Journal of the Iron and Steel Institute, Vol. L. Edited by Bennett H. Brough, Secretary. E. & N. F. Spon, Limited, London; Spon & Chamberlain, New York. Sold also at Offices of the Institute, London. 1897.

Report on Public Baths and Public Comfort Stations of New York City. Published by the Mayor's Committee on Public Baths and Public Comfort Stations: New York City.

Brooks, Robert C. Municipal Affairs. Issued at quarterly intervals. Vol. 1, No. 1. March, 1897. A Bibliography of Municipal City Conditions. Reform Club Committee on Municipal Administration. New York, 1897. Paper. First number, 50c.; later numbers, 25c.

Annual Report of the Board of Regents of the Smithsonian Institution, to July 1, 1894. Government Printing Office, Washington. 1896.

Ries, Heinrich. The Pottery Industry of the United States. Department of Interior, U. S. Geological Survey, 1895-6. Government Printing Office, Washington, D. C. Paper.

Ladd, Loren G., Commissioner of Public Works, and Perry, Fred G., Assistant Commissioner. Annual Report of the Board of Public Works of the City of Pawtucket. John W. Little & Co., Pawtucket. 1897.

Wales, Herbert, President of the Canadian Society of Civil Engineers. Address Delivered at the Annual Meeting, January 13, 1897. Paper.

Exports Declared for the United States. Returns from Consular Districts for Quarter Ended September 30, 1896. Supplement to Consular Reports No. 196 (January, 1897). Government Printing Office, Washington. 1897. Paper.

Thompson, Almon D. Fifth Annual Report of the Department of Public Works of the City of Peoria, Ill., for the Year Ending December 31, 1896. Paper.

Francis C. Moore, President of the Continental Fire Ins. Co., New York. How to Build a Home; being Suggestions as to Safety from Fire, Safety to Health, Comfort, Convenience, Durability, and Economy. Published by the Author. 1897. Paper, 50c.

Report of the Board of Irrigation Survey and Experiment for 1895-1896 to the Legislature of Kansas. The Kansas State Printing Company, Topeka, Kansas. 1897. Cloth.

BOOKS ANNOUNCED.

Andrews, T. Microscopic Internal Flaws Inducing Fracture in Steel. Spon & Chamberlain, New York. 1897. Paper, 40c.

Bell, L. Electric Transmission of Power. The W. J. Johnston Co., New York. 1897. Cloth, $2.50.

Gerard, Eric. Electricity and Magnetism. The W. J. Johnston Co. 1897. Cloth, $2.50.

Langdon, W. E. The Application of Electricity to Railway Working. Spon & Chamberlain, New York. 1897. Cloth, $5.

Lord, N. W. Notes on Metallurgical Analysis. Chemical Publishing Co., Easton, Pa. 1897. Cloth, $1.25.

Steinmetz, C. Proteus, and Berg, Ernst, J. Theory and Calculation of Alternating Current Phenomena. The W. J. Johnston Co., New York. 1897. Cloth, $2.50.

Stillman, T. B. Engineering Chemistry: A Manual of Quantitative Chemical Analysis for the Use of Students, Chemists, and Engineers. Chemical Publishing Co., Easton, Pa. 1897. Cloth, $4.50.

Storer, Francis Humphreys, and Comey, Arthur Messinger. A Dictionary of Chemical Solubilities; Inorganic; A New Improved Edition of Storer's "Dictionary of Chemical Solubilities." By Arthur Messinger Comey. Easton, Pa. 1897. Cloth, $5.

Bennett, Frank M. The Steam Navy of the United States; A History of the Growth of Steam Vessels of War in the United States Navy, and of the Naval Engineer Corps. Warren & Co., Pittsburg, Pa. 1896. Cloth, $5; half Turkey morocco, $7.50; full Turkey morocco, $10.

Kinealy, J. H. Low-Pressure Steam-Heating Charts for the Use of Architects, Surveyors, Contractors, and Steam Fitters. Spon & Chamberlain, New York. 1897. Cloth, 80c.

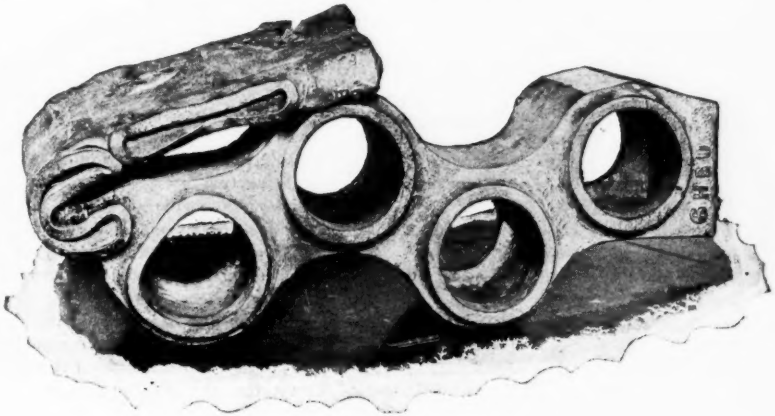
IMPROVED MACHINERY

NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

"Flowed" Steel.

THE illustration here presented shows an example of a new departure in the art of making alloys or mixes for high grade steel castings. Something over a year ago the Aultman & Taylor Machinery Co., of Mansfield, Ohio, started to have a series of experiments made with a view to obtaining a mix for steel castings which should equal, if possible, in its chemical and physical properties, the best boiler-plate steel. After a long series of expensive trials a mixture was discovered which gave remarkable results.



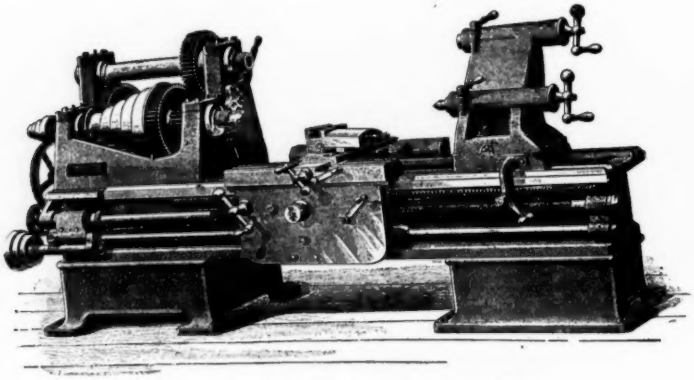
A HEADER MADE OF FLOWED STEEL.

Owing to the high price of some of the alloys used, castings made by this process are very expensive, costing from 6c. to 8c. a pound in the rough, but for the particular purpose for which they are designed they are much cheaper to use, even at this price, than the ordinary steel castings at less than half the cost per pound.

Castings made by this "flowed" steel process are absolutely free from flaws, defects or blowholes, and are uniform in their texture throughout. Every piece of the metal is guaranteed to have an elongation of not less than 25%, and a reduction in area of not less than 50%, with an 8-in. test piece. Some of the samples have shown an elongation of 31% and a reduction in area of over 60%. The metal can be worked cold as well as, or better than, steel plate.

The basis of the mixture is open hearth steel of the finest quality. "Flowed" steel is used by the Aultman & Taylor Machinery Co. in manufacturing crossboxes, flanges, etc., in all their Babcock & Wilcox type of boilers. Where this type of boiler is manufactured by them for a working pressure exceeding 225 lbs. to the square inch, they also use it in the "headers" into which the boiler tubes are expanded.

The figure shows a header of this type, six tubes high. It will be noticed that the header for a space of two tubes in length has been flattened out and then bent back on itself. It is extremely doubtful if that experiment can be succesfully performed on a steel forging of any description. The remarkable physical properties of the metal are further exhibited in a series of photographs shown by the firm. The borings and turnings, which form the subjects, were photographed just as taken from the scrap pile, without any effort to obtain samples out of the ordinary, and they evidence most unusual tenacity and elasticity.



A NEW DOUBLE-SPINDLE LATHE. FRONT VIEW.

A header made in this manner possesses two very material advantages over a header made of forged steel. First: there is no weld to be made, which avoids one great element of weakness in forged headers. Second: the walls of the header can be thickened at will where the strain incident to its use requires greater strength than at other points. This is especially desirable at all corners in the header, as the strains are greatest there. With the forged-steel header, the process of manufacture thins the metal at these very points of greatest strain, or an exact reversal of what should pertain to give best results.

The same holds true in regard to crossboxes or saddles on the drums of boilers for the reception of the nipples connecting the drums to the headers.

In this connection we have been requested by the Cahall Sales Department, Pittsburg, to state that "flowed" steel is a special mix of open hearth steel manufactured under a secret formula which belongs to them alone; and the knowledge of its preparation is in the possession of no one except the Penn Steel Casting & Machine Co. of Chester, Pa. Hence, "anyone offering either headers, crossboxes, or flanges made of 'flowed' steel, is doing so with intent to deceive the public." The Penn Steel Casting & Machine Co. also state, in a letter addressed to the manufacturers: "we consider the special mixture for flowed steel we are making for you, your property of which you have the sole right, and that we never have nor never will furnish flowed steel to anyone but yourselves unless authorized by you. Neither will we give to anyone any information as to the formula under which this special mixture is made."

A New Double-Spindle Lathe.

MESSRS. DIETZ, SCHUMACHER & BOYÉ, Cincinnati, O., have recently introduced an improved lathe which solves the problem presented to the man, three-fourths of whose lathe work can be done on a 26-inch lathe, but who occasionally has a job of boring or turning which requires more swing in order to handle it. The usual solution of such a problem is "raising blocks" for head and tail stock. These are by no means satisfactory. It takes much time to put them in and remove them; they usually make trouble with the feed arrangements; when the large work is put on a lathe so raised, the rest must be drawn out so far as to render the tool very poorly supported; and a lathe once raised will spoil the alignment in both positions and will never be satisfactory again.

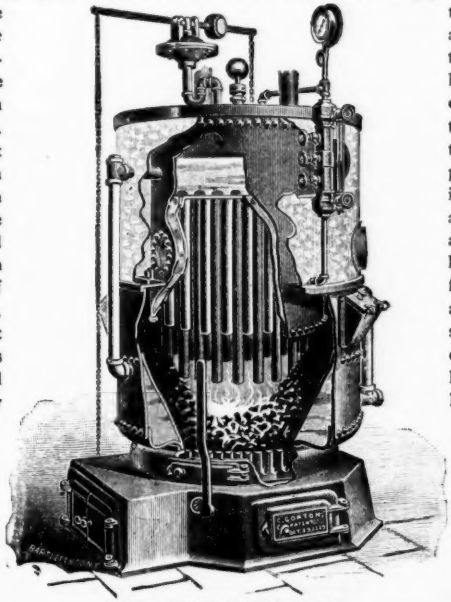
As shown in the front view, the lathe is adapted for use on the smaller work, and is no different from the regular 26-inch lathe of the same make, except that the tail stock is somewhat heavier than it otherwise would be. When the larger work comes along, it is only necessary to connect up the gears by pressing the lever down, and putting a suitable face-plate or chuck on the upper spindle and placing the work on the upper pair of centers; an extra tool post being provided for bringing the tool up level with the center if this is desired, though it is, of course, not always necessary.

This lathe is much better for the range of work within its capacity than a 26-inch lathe would be with raising blocks, while it is also more convenient and efficient for the smaller work than a 44-inch lathe would be, other things being equal. Circulars and further information will be gladly furnished by the makers on application.

It Burns the Smoke.

THE tendency of soft coal to deposit soot and unconsumed carbon on the heating surface of the boiler in which it is used has given so much trouble, that its use in house-heating boilers has been rendered far from being economical, in spite of its cheapness. The trouble is caused by imperfect combustion, and ceases when perfect combustion is attained. Take, for example, the mechanical stoker now used to a large extent with power boilers. By its use even the finest soft coal can be continuously fed into the fire box without visible smoke from the chimney top. Complete combustion is obtained by feeding the coal to the furnace more uniformly than it is usually fed by an engineer. (See an article on Mechanical Stoking in the February '97 number of the ENGINEERING MAGAZINE.)

The Gorton Soft Coal Boiler, here illustrated, is especially constructed to burn the soft coal which is so abundant in the southern and western states. Instead of using a mechanical device for supplying coal to the fire-pot, this work is accomplished by gravity. The coking chambers and coal reservoirs are located between the lower outer surface of the boiler, and the upper part of the water-leg, so that the coal feeds down into the fire just as it is required. The fire-pot is so constructed that sufficient additional air is drawn through the fingered ring at the lower edge of the coking chambers to ignite the gases arising from the coking process. This gives perfect combustion, which means economy in fuel, and prevents the deposit of soot and unconsumed carbon on the heating surface of the boiler and, further, makes use of that part of the fuel which is wasted when soft coal is used in ordinary fire-pots. This boiler is manufactured by the Gorton & Lidgerwood Co., New York, and they claim that it is the only boiler that will burn soft coal by coking it before feeding it down on the fire, thus insuring the greatest economy and reducing the cost of running below that of any other heating boiler on the market.



A SOFT-COAL BURNING BOILER.

A Large Rand Compressor.

A RECENT issue of a Canadian paper contains an interesting account of the christening and starting up of a large Rand Compressor recently installed in the Le Roi mine at Rossland, B. C. The compressor will be known as the "Senator," and is to be used for running all the pumps and hoists at the mine in addition to operating 40 drills. It is described as a beautiful piece of mechanism in every detail of its construction, and is fitted with the latest type of mechanical air-valves, automatic governors, etc. It has the distinction of being one of the three largest compressors in use in the northwest. The machine is of the latest improved type, with Corliss compound condensing engine; steam cylinders 22 × 40 × 48 inches stroke; air cylinders, 22 × 34 × 48 inches stroke, with intercooler. The Rand Drill Company, 100 Broadway, New York, were the builders.

The "Centaur" Porous Terra-Cotta Brick.

THE well-known firm of Henry Maurer & Son, New York, have lately patented and introduced to the building trades at home and abroad a terra-cotta brick which has special claims upon the interest of those concerned with the problems of fire-proof construction. It is represented to be absolutely fire-proof, and though seemingly as hard-burnt as a front building brick, and as dense, its porosity is equal to, if not exceeding, that of hardwoods. Nails have been driven into this brick its entire length as closely as they could be, without causing either splitting or chipping; and the tenacity inherent in this material is such that it becomes as

difficult to draw them as when driven into hardwood. It is nearly impervious to the weather and is particularly adapted for partitions, furring, roofing, column- and girder-covering in all buildings. It can also be employed in connection with common red brick, in any and all work where nailing is requisite.

From these qualifications it must readily occur to every carpenter, mason, or contractor what a great saving in time, labor and expense the use of this brick involves. Samples and prices will be furnished by the makers on application.

Long Distance Transmission.

THE success of long-distance electrical transmission can be safely gaged by the experience of those actually operating a plant; and in this connection our readers will be interested in the following extract from a letter written by Mr. John J. Seymour, President of the San Joaquin Electric Company, operating the San Joaquin River-Fresno transmission, to the General Electric Company, which installed the plant. He says

"It affords me great pleasure to write you regarding the successful operation of the long distance transmission plant installed for our company. The entire plant as furnished has been in practical operation for a period of several months. The 35 miles transmission has given us no trouble whatever. Our load at present consists of 145 arc lights, 5000 incandescent lights, and 410 H. P. in motors, the latter including 180 H. P. for the Sperry flour mill and 75 H. P. for the city pumping-plant. All of the machinery doing this work has worked with perfect success from the start."

"The incandescent lights have most of them been newly wired in, thus enabling us to properly balance the load and the regulation has given us no trouble whatever. During extensive tests, it was impossible to find more than two volts variation between any lamps on the system. Lights so furnished seem to me to be better than incandescent lights usually furnished in San Francisco and other cities of the State."

A New Ruling Pen.

MESSRS. THEO. ALTENEDER & SONS, Philadelphia, have just introduced a ruling pen which will find glad welcome among draughtsmen the world over. It is what they call "Alteneder's Lever Ruling Pen," and its notable improvement consists in the fact that it may be easily cleaned without altering the line-adjustment, an advantage which every practical draughtsman will appreciate.

A NEW RULING PEN.

The pen is made in one piece, with the upper blade in the form of a spring, the action of which is such as to constantly press the points together. The adjusting-screw is fitted to the upper instead of the lower blade (as is usual), and merely bears against the inner surface of the latter; thus separating the points to obtain the desired width of line.

A lever, having parallel arms, is pivoted to the lower blade, and is provided with a bar connecting the two arms and located between the blades. When the lever is lifted, the bar raises the upper blade and holds the points apart for cleaning.

A Change of Name.

THE corporation heretofore doing business in New Jersey, New York and elsewhere under and by the name of "W. A. Cook & Bro.'s Co." has recently, pursuant to the laws of the State of New Jersey, changed its corporate name under which such corporation was and is organized, to that of "LAMBERT HOISTING ENGINE Co.," under which name it will continue to do business in the same line as heretofore.